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SCIENCE EDUCATION

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SCIENTIFIC MANPOWER: THE PROBLEM AND ITS SOLUTION

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Not long after World War II ended, in a period when the Nation realized that the peace was at best troubled, a government report sounded clear warning that trained scientific workers were in short supply: ". . . war curtailment of education, plus its after effects, deprived the nation of about half its normal increase in scientists—35,000, including some 5,000 doctors of science. The shortage of scientists is the product of a sharply increased demand, accompanied by a less-than-normal supply."[1] A year later the President's Commission on Higher Education reported a lack of trained scientific personnel to staff research and development laboratories of industry, the universities, and various agencies of government, and assigned as a cause our failure to safeguard the development of scientific manpower during World War II.

That there should be concern about this state of affairs was and is inevitable. At some times and in some places it has been enough to sit back and wait for supply to catch up with demand, but in the world of today it is manifestly unsafe to drift with the current, for, as Benjamin Fine[2] has pointed out, the Soviet Union and its satellites have no such attitude of *laissez faire.* It seems apparent that the Soviets have embarked upon a state policy of training scientists in numbers, that they currently have some 300,000 students in technical schools of university rank and 1,600,000 students in intermediate technical schools. There is strong suspicion that they are training two or three times as many engineers each year as we train in the United States. We train three-fourths of our Ph.D. recipients in the humanities, and the Soviets train three-fourths of their doctors in science and related fields. Moreover, science is stressed throughout the Soviet program of education; about one-third of elementary school instruction and 40 per cent of the secondary school program are devoted to science and mathematics. As the *Engineering and Scientific Manpower Newsletter*[3] puts it, "Anyone who is inclined to discount the effort that the USSR is making to train and to utilize specialized personnel should be brought up short by the facts and figures assembled by Dr. Trytten. . . . There is no element in this comparison from which Americans can draw satisfaction or take comfort."

When we examine United States Office of Education figures on degrees conferred by institutions of higher education in the United States for the academic year 1950–1951, some significant data appear; the

[1] J. R. Steelman, *Manpower for Research,* Vol. 4 of *Science and Public Policy,* Washington: U. S. Government Printing Office, 1947, p. 3.

[2] Benjamin Fine in the *New York Times,* November 7, 1954.

[3] *Engineering and Scientific Manpower Newsletter,* March 10, 1954.

distribution of bachelor's degree according to college majors was in part as follows:

Bacteriology	730
Biochemistry	198
Biology	8,797
Botany	410
Chemistry	8,258
Geology	2,717
Meteorology	104
Physics	2,778
All other majors	361,360

Now of course the significant thing about these figures is the fact that college science majors constitute such a small group in comparison with the college group as a whole. Attention is also directed to the very small group of physics majors in a world that is supposed to have entered the atomic age. Partial reports on college science majors, moreover, indicate that the situation has not improved since 1950–1951; in fact, there is indication that enrolment in chemistry and physics courses is on the down grade, although of course college enrolments in general have declined somewhat since the period following World War II when veterans filled the classrooms.

The concern about the existing situation is not alone one of national security. For if there were no security problem, the present and future needs of industry for scientific workers and technicians would of itself create a serious concern. Scientific discovery coupled with technological development has remade the world, and it is a world that is dependent upon a supply of research scientists and administrators, technologists who make applications of discoveries, and thousands of technicians who produce the ultimate materials and services. We have only to compare the scientific working force in the United States over a period of 50 years to note the profound change: in 1950 there were about a million people in the working population who could be classified as scientists or technologists, whereas in 1900 this group numbered less than one hundred thousand.

So today we frequently hear the questions: "Why do such relatively small numbers of college students major in the sciences?," and "Why don't we have more engineering students?" Objective answers to such queries are not readily available, but there are some evidences which strongly suggest that the answer may be found in study of secondary school science programs and enrolments. Johnson [4] summarizes United States Office of Education figures on the percentages of students in grades 9–12 enrolled in science courses as follows:

	1922	1928	1933–1934	1948–1949
General Science	18.3	17.5	17.8	20.8
Biology	8.8	13.6	14.6	18.4
Chemistry	7.4	7.1	7.6	7.6
Physics	8.9	6.8	6.3	5.4

During the period from 1922 to 1950 the high school has, of course, increased in population, so that while there has been a decrease in the percentage of students enrolled in physics, for example, there has been actual increase in the total number of students who take the course. However, there is no particular reassurance to be derived from contemplation of the figures, for it is evident that the odds are against a given student taking any science course in grades 11 or 12.

As a matter of fact Johnson [5] cites another group of equally revealing figures for the year 1947–1948, which show the percentages of high schools offering certain science courses during the fall term. These figures are:

	Per Cent
Ninth-grade General Science	74
Biology (usually tenth grade)	85.2
Chemistry	49.4
Physics	47.8

What the evidence indicates is that while secondary schools quite commonly offer courses in general science and biology, a large number do not offer chemistry or physics during a given term. It is likely

[4] Philip G. Johnson, "Occurrence of Science Courses in American High Schools," *Bulletin of the National Association of Secondary School Principals*, January, 1953, p. 24.

[5] *Ibid.*, p. 22.

to be the small school which omits these courses from its offering, or gives them only in alternate years. Thus, some additional data cited by Johnson [6] indicates that in schools of 50 to 74 students, only 1.6 per cent enrolled in chemistry and 1.9 per cent enrolled in physics, whereas in schools having a population of over 2,500 students, 8.5 per cent enrolled in chemistry and 7.2 per cent enrolled in physics. Similarly, many high schools now offer no mathematics except a ninth grade course.

From the standpoint of this discussion, then, the small high school appears to be something of a problem. Apparently it has often eliminated the more costly laboratory science as a measure of economy, and other studies suggest that it has also reduced its offering in mathematics to the vanishing point. Here we find more than a little suggestion that in our concern to provide some type of education for everyone we have sometimes lost sight of the student having more than average ability, and have failed to provide for his potential development—especially in the area of science and mathematics—so that when he enters college he is likely to be handicapped if he attempts a major in a science field. Let us also note that while this student is being denied contact with science education in high school he is likely to cultivate an interest along other lines.

In considering the overall problem of scientific manpower it is also pertinent to inquire what is happening to the science teacher, and particularly the science teacher of the secondary school. We are aware, of course, that the wave of population increase which was part of the backwash of World War II has only begun to be felt in the elementary schools of the Nation, will not spend its force until 1960, and will inexorably produce a similar population problem in first the junior high schools and later the senior high schools. In fact, projected population figures indicate that high school enrolment in 1965–1966 will approximate 12 million—about twice what it was at the end of World War II. In view of these considerations, it is not surprising that various types of teachers are in short supply today, and that we may anticipate a problem that will become more difficult by far before we may hope for improvement.

As the National Education Association Research Division [6a] sums up the situation, the growing problem of the high school involves the fact that its student population is on the increase, the number of college graduates qualified to teach in high school is decreasing, many of the qualified potential teachers do not take positions in education, and present sophomore and junior college classes are smaller than those of the preceding year, which means that the potential supply of new teachers must shrink to still smaller proportions before we may hope for a reversal of the process.

As additional evidence of what is happening to potential teachers it is illuminating to consider the occupations of college graduates from thirteen states and one territory, who received their degrees between September 1, 1952 and August 1, 1953 having satisfied the requirements for teaching certificates in secondary school chemistry and physics. As of November 1, 1953, 79 of these people were actually teaching, 52 were continuing advanced study, 62 were in the Armed Forces, 48 were otherwise gainfully employed, and none was known to be seeking a position.[7] The question as to why so many of these trained science teachers do not accept teaching positions is challenging; the answer is to be found in a complex of factors

[6] Philip G. Johnson, *The Teaching of Science in Public High Schools,* Federal Security Agency, Office of Education, Bulletin 1950, No. 9, p. 8.

[6a] National Commission on Teacher Education and Professional Standards, National Education Association of the United States, "The 1954 Teacher Supply and Demand Report," *Journal of Teacher Education,* March, 1954, pp. 3–4.

[7] National Commission on Teacher Education and Professional Standards, *op. cit.,* p. 21.

which range from the needs of national defense to the relatively low financial rewards that teachers receive. But one conclusion is inescapable: if we need about 5,000 new secondary school science teachers per year, as apparently we do to maintain the present program alone, we must train a considerably larger number for such a career, recognizing that in a free society a large proportion of individuals will adopt careers unrelated to their training.

With an increase in the high school population in prospect, the need for new secondary school science teachers is destined to become more pressing as the years go by, assuming that the science offering remains essentially as it is today. Each year a 7 per cent replacement of secondary school science teachers takes place, so we may predict that in 1960 the annual need will be about 5,800 new science teachers.[8] Now when we compare this prospect with the numbers of men and women preparing to teach science in recent years an alarming trend becomes evident: in 1950 some 9,096 were trained to teach secondary school science, but the figure dropped to 7,507 in 1951, to 5,246 in 1952, to 4,381 in 1953, and to 3,978 in 1955—a total decrease of 56.3 per cent in this short span of years.[9] It is, of course, evident that we have not trained enough certifiable science teachers in the past year to meet the normal replacement need. Two things can and do happen when this state of affairs exists: some schools are forced to man the classrooms with relatively unqualified teachers, and some schools abandon the science offering; the former solution is likely to result in poor instruction that will not maintain the interest of students having science aptitude, the latter means no science instruction at all. As Bowles[10] sums up the situation: "The results of all of these factors appear to promise an unhappy downward spiral of fewer teachers teaching more students."

The sorry part of the story is our growing recognition that the secondary-school science teacher is a key figure in determining whether or not numbers of young people will be encouraged to pursue scientific careers. Patterson,[11] reporting on the thirteenth annual science talent search for the Westinghouse science scholarship, makes the point that the contestants were asked, "What one person has been most influential in the development of your scientific career." Out of the 40 boys and girls selected for the Science Talent Institute, 27 indicated that secondary school science teachers or heads of departments were responsible, and 11 others assigned the credit to professional scientists of one kind or another.

Evidence of another sort comes from a study recently completed by Paul Brandwein,[12] concerned with 82 secondary school science teachers who had been identified as successful in stimulating young people to enter scientific careers. Various facts about this select group of teachers were challenging and perhaps significant, among them the following: they averaged about 40 years of age and intended to continue in teaching, more than 90 per cent had at least a Master's degree in science and had published at least one paper on a scientific or educational subject, over 50 per cent had previously been college instructors, all had been officers of local or national teach-

[8] Conference on Nation-wide Problems of Science Teaching in the Secondary Schools, *Critical Years Ahead in Science Teaching*, Harvard University Printing Office, 1953, p. 17.

[9] See National Commission on Teacher Education and Professional Standards, *op. cit.*, p. 9.

[10] Frank Bowles, "The Future Supply of Scientists," *The Educational Record*, April, 1954, p. 113.

[11] Margaret E. Patterson, "The Key to our Scientific Manpower Shortage, Science Teachers and the Science They Teach," *Books in their Courses*, Vol. 12, No. 2, April, 1954, p. 1.

[12] Paul Brandwein, *The Gifted Student and His Commitment to Science in the High School*, Forest Hills (New York) High School (mimeo.), 1954, Chapter 5.

ers organizations, and all had participated in work concerned with course-of-study formulation or revision. As a group these teachers were well trained in the subject matter, they liked children, they had senses of humor, and they upheld superior standards of achievement.

Now the teacher Brandwein describes is our man of the hour when we seek solution for our scientific manpower dilemma. For he is a teacher who can maintain and develop the science interests of students, and if he influences enough individuals the problem will be solved. But there is one formidable difficulty: this type of teacher is in very limited supply, and facts previously cited suggest that the supply will be even more limited in the near future. So at this point we may come to a first conclusion, which is that *initial attack upon the scientific manpower problem must be concerned with the development of an adequate corps of secondary school science teachers.* At the same time, it is also necessary to have *an adequate program for teaching science and mathematics.*

The foregoing are the two minimum requisites for a satisfactory program of science and mathematics in the high school, and if we fail to produce such a program we may be assured that college enrolments in the sciences will remain at a low level and that the need of our culture for scientists and technologists will not be met. So it is appropriate to inquire what we are doing about the science teacher and about the potential science students. The answers are fairly well known; we talk about the necessity of providing better financial rewards for teachers but we generally put any surplus money into new buildings, we provide a few scholarships and fellowships for gifted students but the number of individuals who profit in this manner is too small to make real progress toward solution of the problem which confronts us.

During the past year the writer had the privilege of attending the fifth Thomas Alva Edison Foundation Institute, sponsored by the Engineering Manpower Commission of Engineers Joint Council and the Scientific Manpower Commission, and attended by representatives of education and industry. Among the recommendations that were there formulated [13] were the conclusions that local Boards of Education should be urged to ". . . increase the financial support to teachers, based on merit, who take advanced training in science and mathematics," make use of scientific and engineering resources of communities in instruction, ". . . insure that all students receive a thorough grounding in mathematics beginning with elementary arithmetic," and ". . . support the science and mathematics teacher in exploring and experimenting with new ways of interesting students in science and engineering."

Meanwhile the National Science Teachers Association has given rise to the Future Scientists of America Foundation which by virtue of a grant from the American Society for Metals, conducts annual programs of Science Achievement Awards for students and Recognition Awards for science teachers. On another front various industries support scholarships and fellowships for science teachers, summer workshops for science teachers, and even programs in which science teachers are given employment by local industries during the summer months. These recommendations and these works in progress are all to the good, but are they enough to meet the challenge? To this the writer must say no; after all, we are not talking about the education of a few dozen scientists, we are concerned about the annual production of several thousand scientists and scientific technicians.

And the bottleneck which confronts us

[13] Report of the Conclusions of the Fifth Thomas Alva Edison Foundation Institute, "Elementary and Secondary Education and the Survival, Strength and Growth of the United States," 1954, p. 6.

is clearly the lack of competent secondary school science teachers and the rather faltering program of physical science [14] and mathematics in the schools, and particularly in the smaller schools. We must have our adequate corps of secondary school science teachers and we may need a rejuvenated curriculum in physical science and mathematics, and these are the obvious points of attack if we are seeking far-reaching results.

A few weeks ago a Cabinet Committee report,[15] concerned with the training of future scientists and engineers recommended that primary responsibility be vested in ". . . educational and professional organizations, the foundations, industry and labor." If there be any disposition to take up this challenge, attention is directed to the bottleneck described in these pages. Fellowships and scholarships for a limited number of future scientists exist and serve a useful purpose, but in the last analysis they can have only minor effects upon the scientific manpower supply. *The crying need is fellowships and scholarships for science teachers*—grants which will enroll hundreds of superior individuals among the ranks of high school science teachers. One such teacher can influence hundreds of students, and the effect is not evanescent, but one which continues through the years, and will enable us to move forward on the broad front essential to our life and times.

Our conclusion, then, is relatively simple: give us an efficient corps of secondary school science teachers; they will resolve the curriculum problems, and they will give us the scientific manpower that is essential to our desires, our comfort, and our security.

[14] In terms of student enrolment and offering, biology fares rather well in secondary schools at the present time.

[15] As reported by Joseph A. Loftus in the *New York Times*, December 6, 1954.

AUTOMATION—A CHALLENGE TO EDUCATORS

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DURING the past decade, a series of relatively unpublicized, but highly revolutionary new production techniques has quietly appeared upon the American industrial scene. These new techniques, often referred to as automation or automatic process control techniques, are the products of a new science called Automatic Control Engineering. This science, in turn, is an outgrowth of the technical advances made during World War II in the fields of electronics, hydraulics, pneumatics, and electro-mechanics.

It is now possible to observe the rapid approach of the era of the automatic factory —a period in which automatic techniques and control devices will be incorporated in each new plant and production process. The essential common element in all of these new automatic process control techniques is the maintenance of a balanced state within a process by means of automatic measurement of a condition representing balance in a system, and provision of a counteraction to any change in this condition [1]. The applications of the techniques produced by this new science of Automatic Control Engineering have made possible tremendous advances in the direction of the completely automatic operation of large industrial establishments.

There are in existence today industrial processes in which successful operation is impossible without the use of automatic control devices. Automatic control is needed because the operations are so rapid and complex, that manual control would require abilities not possessed by ordinary human beings [2]. It may be of interest to note that the most significant advances toward

adoption of the techniques of automation have been made by the chemical, petroleum, printing, textile and communication industries, while considerably less progress in this direction has been achieved by the metal processing industries [3].

It is to be expected that the general adoption of these new techniques by industry may well give rise to a social and economic upheaval which has already been given a name by Norbert Weiner. Weiner chooses to call this the Second Industrial Revolution.

As a result of the First Industrial Revolution, human muscles were largely replaced by machinery. Weiner describes this succinctly when he says:

> "There is no rate of pay at which a U. S. pick-and-shovel laborer can live which is low enough to compete with the work of a steam shovel as an excavator" [4].

The new industrial revolution promises, in a similar manner, to replace the human brain in situations requiring simple routine decisions. The devices developed for this purpose may be classified as automatic, electronically-controlled mechanisms. Another writer has summarized this situation in the following words:

> "Basically, human organs of observation, decision, and effort are being replaced by mechanical, hydraulic, pneumatic, electrical, and electronic devices . . . Manual, menial, tiresome, dangerous, laborious and repetitive operations are being replaced, one-by-one with automatic devices. . . . The rapid evolution of automatic techniques at all production levels is occurring at a rate that justifies the term revolution" [5].

Vannevar Bush has expressed a similar idea in a somewhat less drastic manner in the following statement:

> "Wherever logical processes of thought are employed . . . whenever thought for a while runs along an accepted groove—there is an opportunity for the machine" [6].

It is to be expected that serious social, political, and economic problems are likely to arise as a result of this new revolution. An engineer who recently participated in a round-table discussion on the topic of automatic factories had the following to say concerning the possible effects of automation:

> "My view about the whole field of automation is that it is a subject whose far-reaching implications almost no one has grasped. Correctly applied, it will cause a change in Western living habits and attitudes toward work that will dwarf the effects of the (first) Industrial Revolution. My hope is that . . . we can find a way to reap the vast benefits of automation without incurring too many of its serious penalties"[7].

Some of the important questions concerning the possible effects of automation, to which one can at present merely hazard a guess are the following: How and why is this revolution taking place? Where will it take us? What will be its effects upon our society? Will technological unemployment outrun the expansion of our economy? Does automatic control mean the centralization of economic initiative? Will automation degrade or upgrade the status of men on the production lines? What actions, if any, should be taken by our schools to prepare our children to live in this new world of tomorrow? To what extent will it be necessary to re-assess the roles of leisure and leisure-time hobbies and interests?

Many of the outcomes of the general adoption of automatic control techniques should be of immediate concern to all educators, and especially to teachers of science, social science, industrial arts, vocational subjects, and to those who function as vocational guidance counselors.

In order to help the reader formulate his own answers to some of these questions which have just been raised, this paper will present the basic facts concerning automation, and will attempt to summarize and synthesize recent writings by authorities and experts in various fields associated with automatic process controls.

The meaning of the term automation is similar to certain other terms which have gained acceptance in industry, such as controls engineering, systems engineering, automatic control engineering, feedback engineering, mechanization, and instrumentation. Unfortunately, there is at present

no uniformly accepted definition of automation, the term automation having one meaning for a group of engineers employed in one industry, and meaning something considerably different to a group of engineers in another industry.

The word automation was coined simultaneously by D. S. Harber of the Ford Motor Company and J. Diebold of Harvard University, each one working independently of the other. Diebold defined automation as: "a new word denoting both automatic operation and the process of making things automatic" [8], while Harber's definition, which is the one generally accepted by the automobile industry, describes automation as meaning: "the automatic handling of parts between progressive production processes" [9].

Harber further clarified his definition of automation by describing it as "the tying together of existing machines with electric controls, shuttles, trips, and iron bands. The piece is taken out of one machine, moved to the next one on the line and inserted, all without human help—without the hard work and hazards of manhandling heavy parts and the tedious repetition of feeding machines by hand" [10].

Another writer with similar ideas has defined automation as "the application of automatic operation to continuous production processes" [11]. These concepts limit automation to a modified production line procedure in which the product is automatically carried from one machine to the next, or where a given process is carried on over and over again, no matter what the results. In recent years common usage in the automobile and allied industries has begun to extend the meaning of the term automation to include complete elimination of manual effort at all stages of production, usually by means of complete automatic control [12]. This conception may be illustrated by the following descriptions of automation in the Ford Cleveland Engine Plant:

"Foundry-fresh engine blocks march like those animated TV commercials through a series of 43 machines in a line 1,545 feet long, where 530 cutting and drilling operations are performed on each block. From rough casting to finished product they are untouched by human hands"[13].

"Virtually the only men required on the automated line are job-setters who keep a sharp eye on the process and replace worn tools whenever a tool-meter indicates a tool is nearing the end of its life expectancy. Automation ends with machining. Assembly of the engine is left to the inscrutable coordination of the human hand and eye"[14].

A somewhat improved and much broader definition of automation is found in the following statement:

"Automation is defined as the use of automatic control, associated with some type of measurement, for the control of quality and reduction of costs in production. The measurements may be based upon the direct measurements of any variable, or they may be the error signals representing deviations from a control point"[15].

This may serve as a satisfactory working definition of automation if to it is added that automation also includes the utilization of "sense organs" such as thermocouples, photo-cells, and transducers which measure such variables as temperature, pressure, rate of flow, frequency, and pH. By means of these "sense organs" the automatic control system can "observe" how well its instructions have been carried out and can then modify these instructions in accordance with its own "observations." The net result of automation is that the machines and processes are related and coordinated to the extent that the complete transfer from raw materials to a useful end product is accomplished automatically without the use of human hands [16].

Several different reasons have been advanced for the growth, development, and adoption of automatic process control techniques. One writer stresses the economic factors, pointing out that only the efficient producer can survive intense competition, and worker injury or work stoppage can no longer be tolerated economically [17]. This writer and several others also point out that automatic, continuous, high-speed processing operations are particularly applicable to the handling of fluids, since they allow greater fluid velocities of throughput, and

at the same time decrease the amount of stored liquid capacity which would otherwise be required in order to allow for surges. The operation of these factors may be noted in modern petroleum refineries which are no larger than those built 15 years ago, but which have capacities many times greater than those of the older units. In these newer refineries, the utilization of automatically controlled equipment has resulted in savings in process equipment costs and in lower operating costs per unit of throughput [18].

Another way in which the use of automatically-controlled equipment produces economies is by the reduction in the amounts of fuel and raw materials required. Fuel is conserved by automatically proportioning the fuel input more exactly to meet the process requirements. At the same time, automatic control prevents spoilage of raw materials due to overheating. Raw materials are also saved by preventing the addition of amounts in excess of the theoretically correct proportions by the use of automatic ratio flow control equipment [19].

A second reason for the adoption of automatic controls is the need for increased production. It has been estimated that industrial productivity must be over 40 per cent higher in 1960 than it was in 1950 if our increasing population is to enjoy the type of continuously improving standard of living to which the United States has become accustomed [20]. Since it is estimated that within the same decade the labor force will increase by only 11 per cent, it is evident that in order to accomplish the task of maintaining our living standards, our engineers must exploit to the fullest extent the potentialities of automatic production. With the development of automation it is not inconceivable that many plants will normally be in operation 24 hours a day, 7 days a week, while at the same time, the work week for the human operators will be shortened [21].

An estimate of the increase in production which might be obtained by equipping present-day factories with additional automatic control equipment has recently been made by K. H. Rockey, president of the Armour Corporation. He says:

> "Conservative estimates place at 200 to 400 per cent the increased output available from present machines by merely adding such 'hardware' as we have lately been adding to guns to make them automatic for the armed forces. . . . All the technical know-how to multiply this gain in work turnout now by 5 to 10 has been developed for government projects. Its eventual application to industry is natural" [22].

A third reason for the development of automatic control is that many materials are now produced under conditions which make human control difficult [23]. Advancing technology is coming to depend more and more upon precision in processing, and has introduced standards which would have been thought impossible to obtain only a few years ago. Where the controlled variables, such as temperature, fluid flow, pressure, liquid level, humidity, pH, and specific gravity must be maintained within close limits, automatic control may often be the only answer. Instruments are now available which can measure deviations of these variables before the human eye could detect them on a meter. These devices can also continuously initiate corrective actions to restore the balance. This produces uniformity of product quality far superior to that attained by hand control.

Lack of uniformity can be a serious problem in the field of continuous processing. In such operations, a small variation in the product of one unit which feeds a subsequent unit can become magnified in the latter unit, and this effect can be repeated in the following stages until the final product is completely off specifications. For such processes automatic controllers are indispensable tools, performing tasks that a large crew of operators could not duplicate [24]. This factor is well illustrated by the following recently described incident:

An American firm submitted a design for a modern oil refinery to the officials of a foreign country. This refinery was to in-

clude the usual array of automatic control instruments. Since this foreign country had a considerable surplus of manpower, the designers were asked to omit all automatic controls from the plant, even at the cost of lowered efficiency, so that additional jobs might be made available. The engineers and designers were sympathetic, but came to the conclusion that this could not be done. It was not just a question of lowered efficiency or increased costs—without these automatic control instruments the modern refinery could not function at all [25].

From what has been said it may be seen that the science of automatic control engineering has opened up many new fields of application, due to the fact that automatic control equipment, as compared with similar equipment controlled by human operators, provides the advantages of greater sensitivity, accuracy, rapidity, reliability, efficiency, economy, and endurance. It also results in increased value of product because of greater output and superior quality. Inevitably, as more engineers, designers and executives become acquainted with the potentialities of this new science, rapid developments in the field of automation can be expected [26].

Some writers have pointed out that perhaps the greatest obstacle to the development and adoption of automatic techniques is the lack of information concerning what can be done. What could be done at the present time is far ahead of what is actually being done. The following summary lists some of the functions that can now be performed automatically:

1. Actual machine operation and tending of machines; inspection of operations and of products in various states of completion.
2. Setup of machines and equipment; changing of tools; maintenance.
3. Starting, accelerating, decelerating, and stopping production according to certain rules; emergency shutdowns.
4. Materials and product handling; ordering new materials and components, checking need for product.
5. Programming work sequences; keeping production records; gathering cost information, and related functions [27].

In other words, any kind of work that has been programmed or broken down into a routine series of small decisions, as it has in many mass production industries, can be scheduled for automatic control [28]. In order to understand how these automatic devices can perform their tasks, it will now be necessary to delve briefly into the meaning and significance of the phenomenon of feedback, and to study the operations of simple servo-mechanisms and computers.

All modern, automatic, self-regulating control systems are based upon the principle of feedback. Feedback may be described as a phenomenon in which "information about the output at one stage of a process is returned or fed back to an earlier stage so as to influence its action, and hence to change the output itself" [29].

The idea of using self-regulating mechanisms operating on feedback principles is not a new one. For centuries, windmills have been kept headed into the wind by means of a miniature windmill capable of rotating the whole mill and causing it to face in any direction. When the wind shifts in direction, the sails of the small windmill, which are set at right angles to those of the larger windmill, cause the entire mechanism to rotate until the larger sails are in the correct position [30].

Another early control employing the principle of feedback was Watt's fly-ball governor. This mechanism regulates the speed of a steam engine by feeding back its measurement of the speed or output of the engine. This in turn controls the input of the fuel or steam used to drive the engine.

It may be of interest to note that although the first significant paper on feedback mechanisms was an article on governors published by Clerk Maxwell in 1868, the underlying principles of feedback were mainly developed by communications engineers and scientists who were interested in the theory and design of radio amplifiers and oscillators. In radio work, feedback

has been defined as the "transfer of energy from one point in a circuit back to a preceding point" [31]. Feedback is usually encountered in amplifier circuits, in which a portion of the output from the plate circuit of the vacuum tube is applied to the grid or input circuit of the same amplifier tube, or to the grid of a tube used in a preceding stage of amplification.

When the energy fed back from the output or plate circuit is in step or in phase with the signal appearing in the input or grid circuit, this feedback is known as positive feedback or regeneration. When the amount of positive feedback is limited, the result is increased amplification. This principle has been employed in sensitive regenerative detector circuits found in certain military and amateur radio receivers. On the other hand, when the amount of regeneration becomes excessive, the amplifier becomes an oscillator or generator of electrical waves. The frequency of these oscillations depends upon the values of inductance and capacity present in the amplifier circuit. A common illustration of the generation of oscillations as a result of regenerative feedback is the loud whistle sometimes produced in a public-address system. It occurs when the microphone is placed in such a position that some of the energy from the loudspeaker can be fed back through the microphone to the input section of the amplifier system.

When the energy fed back from the output to the input section of an amplifier is out of phase with the input signal, partial cancellation of this input signal results. This phenomenon is called negative or degenerative feedback, and it produces decreased amplification of the signal. Degenerative feedback is sometimes employed to reduce certain types of distortion produced within an amplifier system. It is also employed in the a.v.c. or automatic volume control circuits found in many common radio receivers. Degenerative feedback, which is produced by the action of a special automatic volume control circuit, has the effect of reducing the strength or loudness of unusually strong incoming signals, to a fixed maximum value. This feature eliminates the need for excessive manipulation of the receiver's manual volume control when ionospheric changes cause a sudden increase in the strength of the signal reaching the receiver.

It is the type of feedback that has just been described, namely negative feedback, that has been generally utilized in automatic control mechanisms. During the past two decades, specialists in such varied and diversified fields as radar engineering, physiology, ecology, economics, and automation have come to recognize this feedback interaction of output and input, of effect and cause, as one of the most useful generalizations employed in modern science. In 1947 the name cybernetics was applied to the new science of studying and correlating the action of feedback mechanisms employed in these varied fields of specialization.

Probably the most familiar automatic mechanism which employs feedback is the thermostatic temperature control, a relatively simple device, whose operation illustrates what feedback engineers call the "closed loop." As the room temperature goes up above a certain previously determined setting or equilibrium point, the device reacts by reducing the amount of fuel supplied to the furnace. When the temperature falls below a certain point, the thermostat causes the flow of fuel to increase, thus raising the temperature. It will be noted that the two variables in this system are interdependent. The setting of the thermostat affects the temperature of the room, while the room temperature affects the thermostat setting. Each variable is a cause and each variable is an effect of the other—a true "closed loop." As a matter of fact, in a mathematical analysis of such a system, it is not possible to distinguish between the controlling and the controlled portions of the system [32].

It may perhaps be of interest to note that the theory of this "closed loop" is basically an extension of the law first formulated by

Le Chatelier in 1888. This law states that if a stress is brought to bear upon a system in equilibrium a reaction will occur to displace that equilibrium in the direction which will tend to undo the effect of the stress.

It should now be apparent that feedback control of automatic mechanisms depends upon the existence of some error or deviation from a standard or fixed value. The system's "awareness" of this error is employed to bring about a correction in such a manner as to make the error as small as possible. In modern automatic equipment, this reduction of error is accomplished by a device called a servo-mechanism or servo system.

It is nearly as difficult for experts in automation to agree upon a definition of a servo-mechanism as it is for a group of theologians to agree upon a definition of sin [33]. The literal meaning of the term servo-mechanism is slave mechanism. Fundamentally, it is a system in which a relatively feeble signal, obtained as part of the large power output of the system is applied to the input section of this system to control the output. The following statement contains an excellent description of the performance of a servo-mechanism:

"Information in the form of messages or stimuli is fed to a system by pick-up devices or receptors. These messages are sent through communications means—circuits or nerves—to a central computing system, or brain and reflex center. This center then compares the incoming signal with a desired value, and operates on the difference or error to produce a signal that is then fed to the power equipment, or effector organs. The latter then move in such a way as to alter the conditions producing the incoming information, and bring it closer to the desired value" [34].

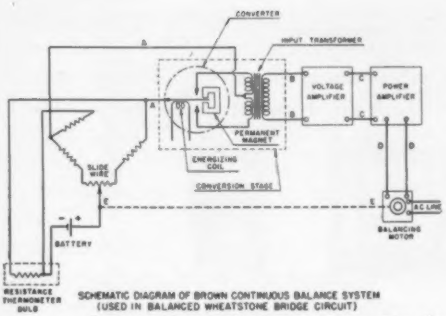
From the above we may derive a definition of a servo-mechanism as a power-amplifying control system which employs the principle of feedback for correction of errors.

An error always exists in a servo system for at least an instant after the initiating signal is applied. Even in the fastest electronic servo system, there is a measurable length of time between the application of the initiating signal and the commencing of the output action desired. This lapse of time may only be a microsecond, but it is still a measurable time lag. Consequently, some error will exist during that period of time [35].

The preceding discussion has indicated that there is a similarity between the action of a servo system and the reactions of animals and human beings. For example, when a person reaches for an object, an estimate is subconsciously made of the distance between his hand and the object. This distance corresponds to the error signal, and it is gradually reduced to zero by the action of the muscles, at which time the hand is then in contact with the object. It is interesting to note that there is a disease known as purpose or intention tremor which is often associated with an abnormal condition in the cerebellum. This disease seems to be related to excessive feedback, in whch the person's hand overshoots the mark when reaching for an object, and goes into uncontrollable oscillation [36].

Another example of the servo-mechanistic functioning of human beings may be observed when a person is driving a car, particularly when he is approaching a curve. Since the car is headed straight, and the road curves, there is an error signal produced by the difference between the direction in which the car is moving and the direction of the road. The magnitude of this error is gauged by the driver's eyes, and the steering wheel is then turned to reduce this error and keep the car on the road [37].

A brief description of the functioning of several simple servo systems will illustrate the general principles of the operation of servo-mechanisms. The primary function of the first servo system to be described is the conversion of electrical signals produced by a thermocouple or other voltage-producing primary element into directional motion. The indicating or recording section of this servo system, which is shown in Figure 1, is connected with a null-balancing circuit. This null-balancing circuit may be

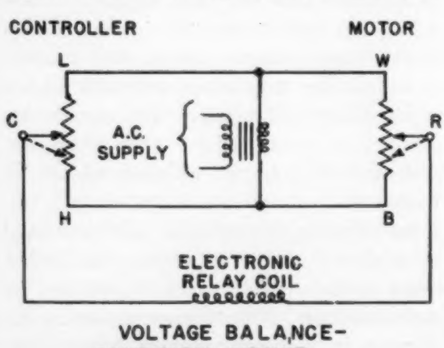


Courtesy Minneapolis-Honeywell Regulator Co.

FIG. 1. Simple Servo System.

defined as one in which the error signal, or difference between the output emf of the measuring circuit and the emf being measured, is zero at the true balancing point [38].

Under normal conditions, the voltage produced by the primary elements equals a standard reference voltage, and the error voltage is zero. When there is a change in conditions, such as a rise in temperature, the emf produced by the primary element will change and the resulting small error voltage will be applied to a vibrating—reed converter. This converter changes the error voltage to an ac signal. The signal is then introduced into an amplifier, the output of which is connected to a reversible, two-phase induction motor which is called a balancing servo motor. One phase of this motor is energized by the amplified error signal, while the other phase is energized by the voltage from the power line. A positive error voltage, produced by an increase in the emf of the primary element, produces a signal which drives the motor clockwise. On the other hand, a negative error voltage, produced by a decrease in the emf of the primary circuit, causes the motor to turn counter-clockwise.



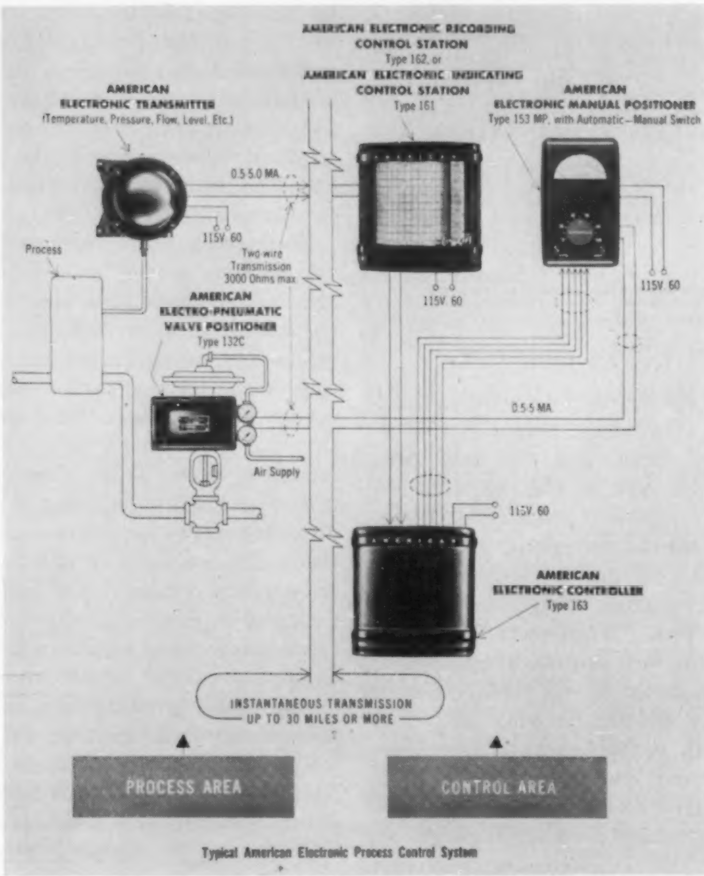
Courtesy Minneapolis-Honeywell Regulator Co.

FIG. 2. Voltage-Type Null-Balance Circuit.

The rotating motor can be used to operate an indicating pointer or a recording pen and to move at the same time, a slide-wire resistor located in the controller unit. This resistor is connected to a similar slide-wire resistor and the combination forms a voltage-type null-balance Wheatstone bridge circuit as shown in Figure 2. The second resistor is located in the reversible control motor, and its sliding contact moves in direct relation to the rotation of the motor shaft. The moving arms of both slide-wire resistors are connected with each other by means of an electronic relay circuit whose function is to detect unbalance in the bridge circuit.

Any change great enough to cause the pointer or recorder to operate will also cause motion of the slide arm of the controller. This creates an unbalance in the bridge circuit. The unbalanced voltage constitutes the input to the electronic relay control circuit. This signal is amplified electronically and operates contacts which govern the power supply to either the "open" or "close" drive windings of the motor. The motor then turns in such a way as to open or close a fuel valve, or take whatever corrective action may be required [39]. As the motor turns, it also moves the arm of the motor slide-wire resistor until a new voltage balance is achieved. When the balance is obtained, the servo system comes to rest [40].

A somewhat similar automatic control system is illustrated by the American Electronic Process Control shown in Figure 3. The instruments employed in this system are a transmitter, a recording control station, a manual positioner, a controller, and a valve positioner. The manual posi-

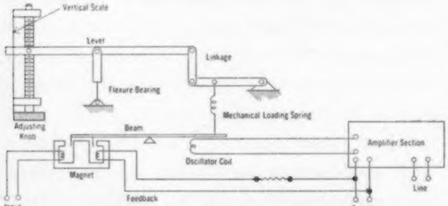


Courtesy Manning, Maxwell and Moore, Inc.

FIG. 3. Automatic Control System.

tioner is used only when the operator desires to switch from automatic to manual control. It is relatively unimportant, and its operation will not be described.

The transmitter is a transducer which converts information concerning variables such as pressure, temperature, flow, and liquid level into electrical signals. These signals are then fed to the recorder section of the control station where they cause a recording pen to produce a graphic record of the electrical signals. The signals are also fed to the set point section of the controller, a diagram of which is shown in Figure 4.



Courtesy Manning, Maxwell and Moore, Inc.

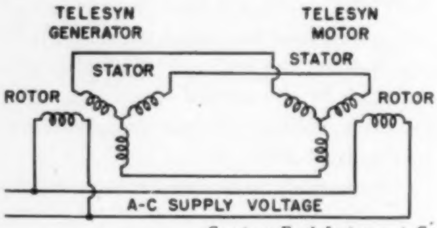
FIG. 4. Controller Set Point Section.

An adjusting knob in this section is used to set the value of temperature, pressure, or other variable which is to be maintained by the controller. The magnet shown in the diagram is part of a microsen balance system, which compares the electromagnetic force produced by the input from the trans-

mitter with the force exerted by a spring controlled by the set point adjusting knob. These opposing forces are applied to a pivoted beam. In addition, a portion of the output signal is also applied to the beam through an electromagnetic coil and provides an opposing force produced by feedback.

The oscillator coil, located close to the outboard tip of the beam, detects any condition of unbalance and causes the amplifier section to produce an output voltage whose polarity and magnitude are dependent upon the deviation of the process from the set point. This dc voltage is fed to the controller as a deviation signal. No deviation signal voltage is produced when the process is exactly at the set point. The deviation voltage which is fed into the controller produces a direct current output of from 0.5 to 5 ma. which is then applied to a valve positioner or to a transducer to control the handling of the process variable [41, 42].

There is a somewhat different type of



Courtesy Ford Instrument Co.

FIG. 5. Selsyn Generator and Motor.

servo system which was first developed for use in radar equipment. This system employs ac signals and its basic component is a device known as a selsyn. These selsyns are also sometimes called telesyns, autosyns or synchros.

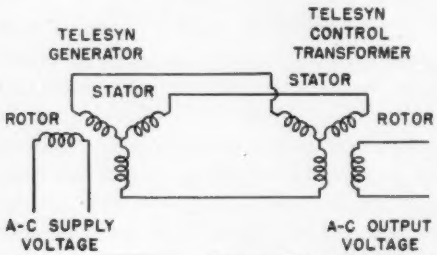
A selsyn may be defined as a device used for the electrical transmission of angular position [43]. A selsyn generator or transmitter can convert the motion of a shaft into an electrical signal, while a selsyn motor or receiver can convert this electrical signal back into motion of a shaft.

The selsyn generator is essentially a small, two-pole alternator. The rotor is turned by a shaft and it has a single coil which is wound around a laminated iron core. The ends of the coil are connected through slip rings to the ac power line. The stator contains three separate coils spaced 120 degrees apart around the stator. The coils are connected in a star or "Y" arrangement so that one end of each coil is connected to a common point, while the other end is connected to one of three different terminal points located on the frame. The selsyn motor is similar in construction and appearance to the selsyn generator and its rotor is also connected to the ac power line, as shown in Figure 5.

Three wires are used to connect each stator terminal point on the selsyn generator with the corresponding stator terminal point of the selsyn motor. When the shaft of the selsyn generator is rotated a certain number of degrees, the resulting shift of the rotor position induces voltages in the coils of the stator which are different from the voltages induced before the shaft was rotated. When these new voltages are applied to the stator of the selsyn motor, a magnetic field is produced in the stator. This causes the rotor of the selsyn motor to turn through the same number of degrees as did the rotor of the selsyn generator. Thus the shaft of the selsyn motor follows the rotation of the shaft of the selsyn generator.

Another way of describing the action of this synchro system is to note that since the rotor of the selsyn generator is supplied with alternating current, and the three stator windings may be regarded as secondary coils of a transformer, three distinct voltages are induced in the stator windings. The magnitude of each of these three voltages varies with the angular position of the rotor relative to the stator. There exists only one combination of these three voltages for any one position of the rotor. Conversely, there is only one position of the rotor which can produce a given combination of stator voltages. When these voltages are impressed across the stator coils of the selsyn generator, the same com-

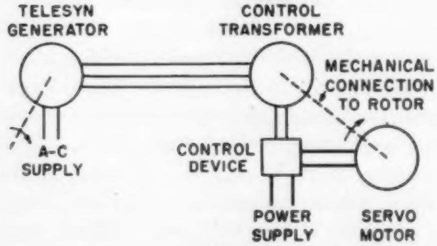
bination of voltages will exist in both stators. Since both rotors are energized by the same ac source, and similar voltages exist across the terminals of both groups of stator coils, the electromagnetic field produced in the selsyn motor will cause its rotor to assume the same angular position relative to its stator as that existing in the selsyn generator. The selsyn motor does not spin continually as does an ordinary motor, but instead maintains an angular relation between rotor and stator that is at all times under the control of the selsyn generator [44].



Courtesy Ford Instrument Co.

FIG. 6. Selsyn Control Transformer.

These selsyns may be used to maintain automatic control of the speed of a large motor. The selsyn transmitter rotor shaft is turned by a small, constant-speed synchronous motor, while the selsyn receiver rotor shaft is turned by the large motor whose speed is to be controlled. The three terminals of each of the selsyns are connected as previously described. If the large motor slows down, the selsyn receiver connected to it will also slow down. There will now be a potential difference between the outputs of the two selsyns. This difference of potential can be amplified and applied as a feedback voltage to the large motor to bring it back to the desired speed.

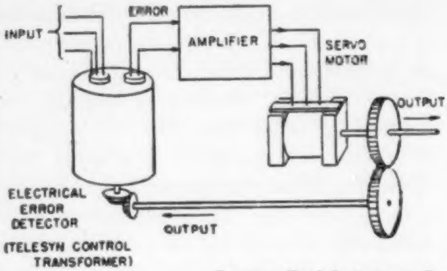


Courtesy Ford Instrument Co.

FIG. 7. Operation of Selsyn Servo System.

In many servo system applications, the selsyn motor is replaced by a selsyn control transformer. This control transformer is essentially the same in construction as the selsyn motor, and the three terminal points of its stator coils are also connected to the three corresponding terminals of the selsyn generator as shown in Figure 6. However, the rotor of the selsyn control transformer is attached to a shaft which is held in a fixed position. The rotor winding is not connected to the ac power line, but is instead used to supply an alternating voltage to a device that controls the flow of energy to a servo motor, as shown in Figure 7. The magnitude of the alternating voltage supplied by the control transformer is a measure of the displacement of the generator rotor shaft relative to the transformer rotor shaft. This voltage is then an error voltage, and can be used to control the servo motor which drives the load and which also turns the shaft of the control transformer until the error voltage becomes zero, as shown in Figure 8 [45].

Some selsyn servo-mechanisms employ an amplifying generator or amplidyne. This is essentially a dc generator with several control fields, and an extra pair of brushes which are short circuited or directly connected to each other. An ac motor turns the shaft which turns the amplidyne. The output of the amplidyne drives a dc motor which is connected to the load. If the dc motor slows down, the selsyn's control transformer delivers an error voltage to the amplidyne control amplifier. This amplified voltage is compared in magnitude and polarity with a reference voltage supplied by the ac power line. The output of the control amplifier flows through the control field coils of the amplidyne with the result that the magnitude of the output of the

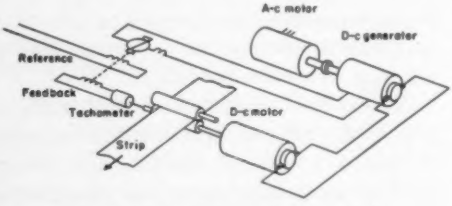


Courtesy Ford Instrument Co.

FIG. 8. Electrical Servo Loop.

amplidyne is controlled by the magnitude of the ac error voltage, while the polarity of the output is controlled by the phase of the error voltage. This amplidyne's output in turn controls the motion of the dc motor connected to the load [46].

It is also possible to design a servo system in which an amplidyne controls the output of an ac-driven, dc generator as shown in Figure 9. The dc generator supplies cur-



Courtesy General Electric Co.

FIG. 9. Amplidyne Control System.

rent to a dc motor which is connected to the load. A reference voltage is applied to one control field of the amplidyne. A feedback voltage produced by the rotation of the load is applied to a second control field. If these two voltages are equal, the resultant field produced in the two coils is zero and the amplidyne is unaffected. If the motor slows down, there will be a difference between these two voltages, and this difference voltage will be amplified and used to control the generator in such a way as to cause the dc motor to turn faster [47].

The question which now naturally occurs is whether, when all of these various devices are put together we will have an automatic factory; or whether there is still missing an important basic component necessary to make a factory fully automatic. Perhaps this question may be answered by relating an incident described in a recent article dealing with a visit to a very modern steel factory, equipped with all of the latest automatic controls and servo-mechanisms. According to the indications given by the dials, gauges, and recorders, one of the furnaces was ready for pouring. However, the workmen didn't pour until a gnarled foreman came along and peered at the molten metal through a piece of smoked glass to see whether it was right [48]. From this incident it should be obvious that as long as basic decision-making steps such as these are performed by the actions of human minds, this production technique can only be described as semi-automatic. The mere use of automatic controls does not make a process or a factory automatic.

The truly automatic factory must contain a device capable of performing the functions of the previously described foreman, and of making the routine decisions needed to produce the largest quantities of products capable of measuring up to the required quality standards. This device should also perform the function of controlling all the operations of the factory in such a manner that the various components do not operate as an aggregate of individual, independently-controlled machines, but perform instead as parts of a single, large, organic unit. Impulses from the factory's sensory elements, conveying information concerning temperature, pressure, thickness, pH, rate of flow, liquid level, etc., would be fed into this device. The device would analyze this data, and feed back information, as a command, to appropriate effector elements such as valve-turning motors, hydraulic servo-valves, pumps, and conveyors located in various sections of the plant [49].

The functions performed by such a device bear a striking similarity to the functions performed by the brain and nervous system of a living organism. It is therefore only

natural that some writers have referred to these devices as mechanical or electronic "brains." Other somewhat more prosaic writers have described these devices as "information machines" whose principal purpose "is not the performance of work but the ordering and supervision of the way in which the work is done" [50].

Fortunately, the work of the automation engineer has been enormously simplified by the fact that devices capable of performing functions similar to those just described are already in existence. These devices, known as computers or data processing machines, were designed by engineers who were working in the fields of anti-aircraft fire control, guided missiles, business calculating machines, and dial telephone switchboards. Although, at a superficial glance, the problems of people working in these fields appeared to be quite unrelated to the problems of designing an automatic factory, it soon became apparent that similar problems of computer design appeared in each of these fields, and that a solution applicable to one of these fields could, with slight modification, be utilized in some of the other areas.

Control systems employed in radar equipment, gun-fire controls, automatic pilots and missile-guidance systems require the use of high-speed computers. These computers are employed in the laboratories to simulate the device under control, and they also function in the final product as the "brain" of the control system [51]. These computers were developed to save long months and years of laborious calculations in the design of equipment, and to make the split-second calculations and decisions involved in the performances of anti-aircraft and guided-missile weapons. For example, in solving a guided-missile trajectory problem, millions of arithmetic operations must be performed on several hundred starting factors [52].

Computers have also been designed to aid large businesses through the mechanization of paper work. Unlike the computers previously mentioned, these computers must do more matching, selecting, arranging and filing [53]. They have also been designed to process vast quantities of original data, classifying it and rearranging it, and storing it for future use. These computers introduced the use of punched cards and tapes for feeding information into the system, and the use of electronic intercommunication systems for transmitting information from one portion of the system to another. The development of language and information theory associated with these intercommunication systems has given rise to the interesting statement that "language is not exclusively an attribute of living beings, but one which they may share to a certain degree with the machines man has constructed" [54]. We ordinarily think of communication and language as being directed from person to person. However, it is quite possible for a person to talk to a machine, a machine to a person, and a machine to a machine" [55].

An example of the commercial application of this type of computer is a recently developed inventory machine now being used by some large chain and department stores. As each sale is made, a record is sent to a central computer which subtracts one from the inventory of the item sold. When the stock is reduced to a certain level the machine prints instructions to replace it [56].

Another computer is employed by large mail-order houses, in connection with their addressing machines. From a list of more than 15 million names, this device can select a list of customers for catalog or special mailings. The selection is based upon information concerning the customer's previous sales history, economic status, interests, geographical location and other data, contained on stencil plates, which are fed into the machine. The machine then produces a mailing list capable of improving the net

return in catalog mailings by many millions of dollars [57].

A third example of computer application is found in the "brain" of the telephone dial system. This device registers and "remembers" the phone number dialed, selects the best of several alternate paths through millions of other phone circuits, rings the called party's bell, disconnects the circuit when the parties hang up, measures the length of time of the call, computes the charge and places it on the bill of the calling party. One writer has said, in discussing devices of this sort:

> "Computer is really an inadequate name for these machines. They are called computers simply because computation is the only significant job that has so far been given to them. The name has somewhat obscured the fact that they are capable of much greater generality. When these machines are applied to automatic control, they will permit a vast extension of the control art—an extension from the use of rather simple specialized control mechanisms, which merely assist a human operator in doing a complicated task, to overall controllers which will supervise a whole job. They will be able to do so more rapidly, more reliably, more cheaply and with just as much ingenuity as a human operator" [58].

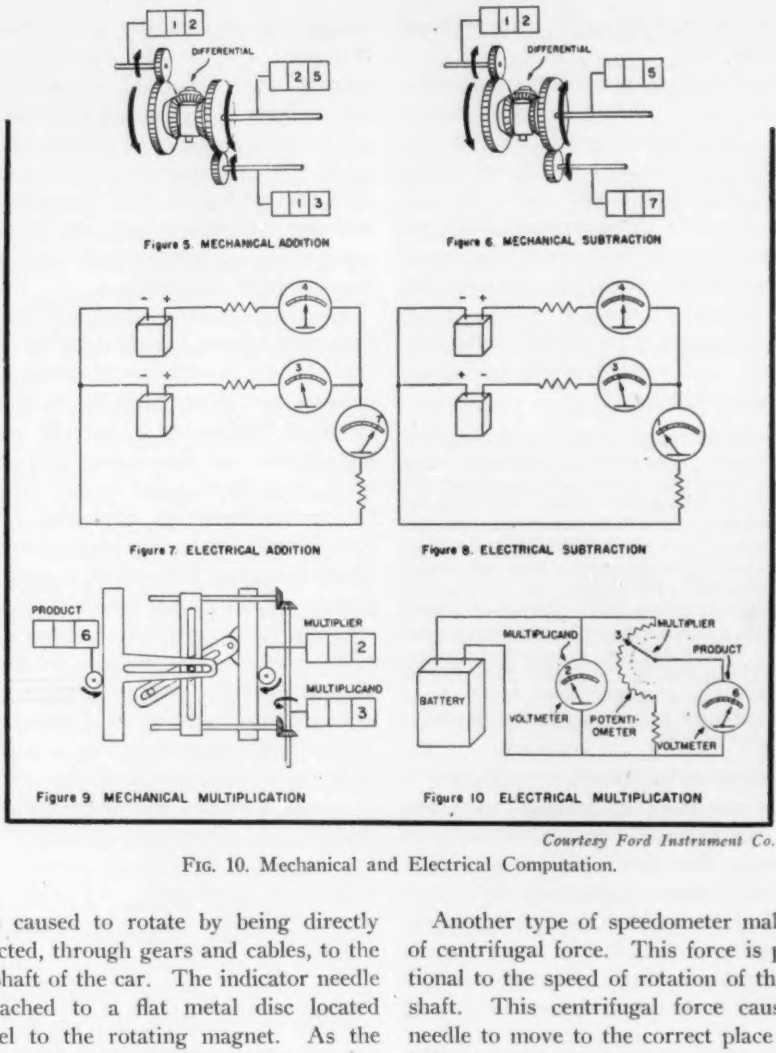
There are in use today, two families or types of computer information machines. One is the analogue type and the other is the digital. Historically, the analogue computer preceded the digital—the first giant mechanical brain developed nearly twenty years ago by Bush at M.I.T. was a member of this analogue family. However, recent developments seem to indicate that most of the large information machines of the future will probably be of the digital variety.

An analogue computer may be defined as one in which "numbers are represented by physical magnitudes, such as the amount of rotation of a shaft or a quantity of electrical voltage or current" [59]. It operates by setting up physical situations which are analogous to mathematical situations. Thus, a group of gears connected to a differential can be used to perform computations involving addition and subtraction. The differential can perform addition by adding the total number of revolutions of two gears. It can also subtract the total number of revolutions of one gear from the total number of revolutions of another gear, and deliver the answer by positioning a third shaft. Other mechanical devices and linkages, such as hollow shaft differentials, ball and disc integrators, and sine mechanisms can multiply, divide, integrate, and compute trigonometric relationships.

Electrical, electronic, hydraulic and magnetic components can similarly be made to perform the operations of multiplication, division and integration. Simple parallel electrical circuits can be used for performing addition and subtraction computations, while multiplication and division operations can be performed by employing electrical transformers, or by applying Ohm's Law, which states that the voltage is equal to the product of current and resistance. By substituting various numerical values for current, resistance or voltage in a simple electrical circuit, these arithmetrical operations are easily performed. Integration and differentiation operations can be performed by using relatively simple circuits containing a vacuum tube and several combinations of resistors and capacitors. A diagram showing some of the simpler electrical and mechanical components and basic circuits employed in analogue computer operations is shown in Figure 10.

An example of a very simple type of analogue computer is the familiar slide rule. This device translates logarithms into physical distances. Distances between points on the slide rule can then be read numerically in such a way that they provide the answers to problems requiring multiplying, dividing, squaring, and obtaining of square roots.

Another frequently encountered simple analogue computer is the common automobile speedometer. Its fundamental operating principle involves the conversion of the rate of turning of a shaft into a numerical indication of speed. A permanent mag-



Courtesy Ford Instrument Co.

FIG. 10. Mechanical and Electrical Computation.

net is caused to rotate by being directly connected, through gears and cables, to the driveshaft of the car. The indicator needle is attached to a flat metal disc located parallel to the rotating magnet. As the magnet rotates, it produces eddy currents in the disc. The disc attempts to follow the magnet, but its motion is opposed by the tension of a spring. When the restoring force of the spring exactly counterbalances the actuating force of the rotating magnet, the needle comes to rest. Since the magnet's actuating force is proportional to the speed of the magnet, and this in turn is proportional to the speed of a car, the instrument can be calibrated so that the needle position indicates the speed of the car in miles per hour [60].

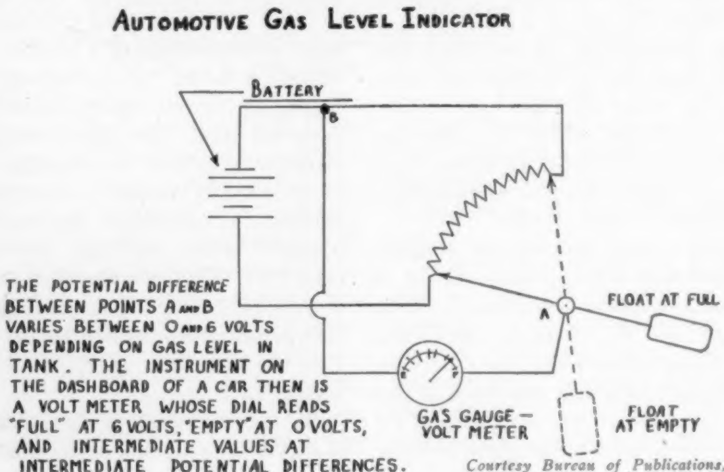
Another type of speedometer makes use of centrifugal force. This force is proportional to the speed of rotation of the drive shaft. This centrifugal force causes the needle to move to the correct place on the indicator dial. In both types of speedometers, it may be noted that the instrument's analogue-type computer has performed an operation of differential calculus, since a stationary needle position, as for example a constant reading of 40 m.p.h., is produced by a constant rate of change of position of the car [61].

A somewhat less common analogue computer is the tachometer or engine-speed indicator, which is usually found on the instrument panels of airplanes and racing automobiles. A generator is geared directly

to the engine crankshaft, and its voltage output is directly proportional to the speed of revolution of the engine. The generated voltage and current are then used to operate a distantly located meter whose scale is calibrated to read directly in revolutions per minute [62].

The automobile fuel gauge is still another example of a simple analogue computer. As shown in Figure 11, the position of a float located in the gas tank depends upon the height of liquid level, which in turn depends upon the quantity of fuel in the tank. In order to convert the level of the float into a proportional voltage, the float is connected to the movable arm of a variable resistor or potentiometer. This potentiometer is connected across the 6-volt car battery in such a way that it functions as a voltage divider. Consequently, the amount of voltage developed between the movable arm and the other end of the resistor gradually decreases as the liquid level drops. This difference of potential is then applied across the terminals of the indicating instrument, which is nothing more than a voltmeter, calibrated to read "full" at 6 volts and "empty" at zero volts. In this manner, an electrical analogue of the gasoline level is transmitted to the indicating instrument [63].

The I.B.M. Test Scoring Machine is another interesting example of a simple analogue computer. This device applies a constant voltage across the pencil marks which are correctly placed on an answer sheet. It then measures the amount of current which is produced. Since the examination score is proportional to the amount of current flowing through the circuit resistances, the numerical score can be read directly on a calibrated ammeter [64].



Courtesy Bureau of Publications, Teachers College, Columbia Univ.

Fig. 11. Automobile Fuel Gauge.

Many of the computers or information machines used to control today's industrial and military devices employ this analogue principle, in which the control apparatus mimics the thing it controls. For example, in analogue control of a guided missile, a small model of a missile in the control station simulates the flight of the actual missile in space. In a factory, a photoelectric scanner can be made to follow the lines of a small model or scale drawing and thus control and guide a machine manufacturing the part represented by this model or drawing.

Differential analyzers and similar analogue type computers have been widely employed in engineering laboratories. Here

the computers are used to simulate a physical problem such as the theoretical flight of an airplane, the trajectory of a projectile, the load upon the distribution network of an electrical utility system. the level of water in a river fed by many tributaries, or the flow of traffic through congested streets [65].

The following illustration will serve as an example of the uses of an analogue computer to help reduce the cost of designing flight controls, by pre-testing the designs while they were still on the drawing board.

The problem was to provide automatic stability that would eliminate yaw or side-skidding oscillation which is sometimes produced when piloting a jet fighter from a standing position into near-vertical flight to an altitude of about 9 miles.

A control system mock-up was designed which generated voltages proportional to the aileron and rudder deflections made by movements of the mock-up stick and pedals. These voltages were fed to an analogue computer internally connected so that its electrical response was analogous to the known characteristics of the plane in flight

The output voltages, varying in proportion to the flght path characteristics of the actual plane under similar stick and rudder variations, provided data on the rate of yaw and roll. Varying these two operating conditions during the simulated performance was merely a matter of turning knobs on the control panel of the computer. In this manner, the designers were able to solve this problem quickly, and without costly flight experimentation [66].

In a very similar manner, an analogue computer was set up in another laboratory to duplicate engine conditions of a turbojet at various flight speeds and altitudes. This permitted testing of the turbojet engine and control system before the engine itself had even completed the developmental stage [67].

Where the given relationships cannot be expressed by a mathematical equation, such as in computing the trajectory of a projectile using drift, superelevation or time-of-flight data for which no equations are known, an additional step is involved when using the analogue computer. From empirical experimental data a cam can be constructed to give the relation between time-of-flight and the range, and this cam is employed as an element in the computer [68].

The digital computer may be distinguished from the analogue type by the fact that instead of measuring, it counts. Instead of responding to a greater or lesser degree, it is an "all or nothing" device, employing discrete signals that either exist or do not exist. The digital computer may therefore be defined as a machine designed to process data consisting of clearly defined numbers, as contrasted with the analogue computer which processes physical quantities [69]. Data must therefore be supplied to the digital computer in the form of numbers, which are processed by the machine. The machine then expresses the results numerically.

As a consequence of this characteristic of digital computers, a device must be used to convert the physical world of the problem into the logical, numerical world of the computer. Such a device is the digital converter, to be described in a later section of this article [70].

The earliest digital computer was the human hand, from which our present-day decimal system was derived. The next development involved the use of stones and small pebbles to simplify the process of computation. This probably led to the invention of the abacus. This interesting device, which was first used over 5,000 years ago, is still employed in Japan and China. Little additional progress in digital computation was made until 1642, when Pascal invented a desk calculator capable of performing addition and subtraction. In 1671, Leibnitz improved upon this calculator by redesigning it so that it could multiply by the process of repeated addition.

The first true forerunner of the modern large-scale digital computer was Babbage's analytical engine, designed in 1833. This device contained an arithmetic section and provisions for memory and programming. The Comptometer was patented by Felt in 1887. Two years later, he added the printing feature to produce the first practical printing adding machine. In 1920, electric motor drives were incorporated into these computers.

The Harvard Mark I Calculator, the first large-scale, general purpose digital computer, was built in 1944 as a joint effort by Harvard University and the International Business Machines Company. This was followed by the construction at the University of Pennsylvania of the all-electronic digital computer called ENIAC (Electronic Numerical Integrator and Computer) and its many present-day descendants such as MANIAC, SEAC, etc., which are in use today in various government and university laboratories [71].

There are two other developments which should not be overlooked in any discussion of the history of digital computers. The first is the development of the familiar IBM punched cards, which can be used to communicate with the computer. These cards can be used to give assignments to the machine, to record its answers, and to form its memory. The second, is the development of the teletype printer, with its accompanying relays and perforated tape. With the aid of this teletypewriter, the human operator can deliver intelligible instructions to the computer, the computer can communicate with the human operator, and submit printed solutions to problems. The teleprinter also enables the computer to communicate with other machines and give them information or instructions through the medium of perforated tape.

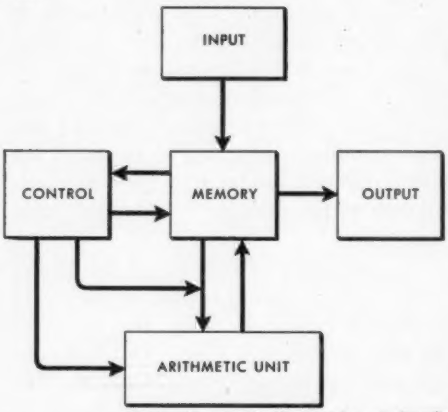
Mention has already been made of the fact that the digital computer operates on an "all or nothing," "go or no-go" principle. Its arithmetic is based upon the binary number system which uses combinations of only two different digits, zero and one. Within the computer, the digit one may be represented by a hole on a card or tape, a closed pair of electrical contacts, a pulse of current flowing down a line, electron current flowing from cathode to plate of an electronic tube, current flowing through an electromagnet, a magnetized area on a wire or tape, a dark area on a photographic film, a charged area on the face of a cathode-ray tube, or a ripple in a tank of mercury. Zero corresponds to the opposite condition, no hole, no closed contacts, no current flowing, no magnetized area, etc. Fortunately, machines have been designed to convert decimal numbers into binary numbers, and then to reconvert the binary numbers produced by the computer's solution of the problem into decimal numbers.

An advantage of the use of the binary system is that when it is used in computers employing electronic tubes, the computer can solve problems of logic. The digits one and zero can correspond to yes and no. The concept of "and" may be introduced by using a tube containing two grids which are normally negative, thus preventing flow of current within the tube. Current will only flow when two separate signals make each grid positive. Current will not flow as long as either grid is negative. In a similar manner, a circuit can be arranged to correspond with "or" concept. In this circuit, if a signal causes either of the two grids to become positive, the tube conducts.

Additional circuits can be designed to give the concept of "neither," and to produce a positive result from two negatives. Thus, digital computers can be employed not only for the purposes of solving problems of computation, but also to solve problems involving the making of logical decisions [72]. In this connection, the Air Navigation Development Board has for some time been considering the use of computing machines at airport control towers to relieve the traffic control men of many elementary stereotyped decisions. Simi-

larly, the National Research and Development Board has been considering the use of computers for making logical decisions in connection with war games [73].

Since a digital computer is a rather complex device, it will probably be easier to understand how it functions if it is broken down into the following five basic components, which are related to each other as shown in Figure 12. These components are:



Courtesy Radio Corporation of America

FIG. 12. Basic Components of a Digital Computer.

1. Input unit
2. Storage or memory unit
3. Arithmetic unit
4. Control unit
5. Output unit [74]

1. *Input Unit*

In the case of the analogue computer, the problem to be solved is implicit in the construction of the machine itself. However, the inherent nature of the digital computer requires an explicit formulation of the problem to be solved by this machine. It is primarily this need for specialized input and output equipment which has thus far restricted the use of the digital computer as a control instrument [75].

The input section of the computer must possess facilities capable of receiving a program of instructions, and handling and reading information regarding the state of the particular process being controlled. This requires the use of teletypewriters, punched cards, punched paper tapes, and magnetic tapes. An electric typewriter is frequently used to convert ordinary decimal numbers to their binary equivalents. When a key of this typewriter is pressed, a series of electrical pulses is produced. These pulses are then recorded on the magnetic tape which is then placed in the Input Unit to supply the needed data concerning the problem.

Another important element in the input stage is the digital converter. This device converts measured variables such as temperature, pressure, level, flow, or shaft position into a coded digital form. Its basic function is to convert an analogue type signal into a number. One way of accomplishing this is by using a pair of synchro motors. One motor is connected to the rotating shaft or other source of analogue-type signal, and the other is connected to a print wheel. The digital data can then be stored or fed into a teletype machine, punch card machine, or into the input section of a computer [76].

The digital converter can also operate in the reverse manner as a digital-to-analogue converter, in which the previously described process of data reduction is reversed to provide control of the automatic factory. Thus, the output of the computer, or a production schedule previously typed on a punched tape, can be converted into an analogue output capable of changing the set points of process controllers, thereby shifting the entire factory from one grade or quality of product to another. Such systems are now being developed for use in steel mills, in the manufacture of sensitized paper, and for the automatic adjustment of processes intended for changing the type and quality of adhesive tapes [77].

2. *Storage Unit*

The storage or "memory" section functions as a blackboard or work sheet for instructions and intermediate answers. It usually consists of a group of electronic or electro-mechanical devices which store in-

formation such as original data, intermediate answers, or instructions until the computer is ready to use this data. A good storage unit possesses the following characteristics: information is readily accessible, it can be referred to once or many times, and the information can be changed or replaced whenever desired.

The usefulness of the computer depends upon the storage capacity of its memory unit, since this limits the size of the program. In addition, it is necessary that the access time be as brief as possible. This term access time refers to the length of time needed to obtain a number from the storage unit and make it available to another part of the computer.

It is obvious that in storage devices in which the bits of information are in time series, the requirements of large capacity and short access time are mutually contradictory [78]. The following are some of the memory devices which have been employed in digital computers:

a. *Punched Cards*

This method provides almost infinite memory capacity, but the access time is excessively long.

b. *Perforated Tape*

This method reduces the access time somewhat. For several years, punched tape has been used in the control units of simple automatic machines such as the robot milling machine developed at M.I.T. for the Air Materiel Command. Numbers for directing the machine's operations are derived from the drawing and specifications of the part to be worked. These numbers are converted into the binary system and punched on tape. Three decoding servos convert the taped commands into shaft rotations. These are transmitted electrically to power servos which control the milling operations. The feeding back of information from the power servos to the decoders serves to eliminate errors [79].

The tape can be kept as a permanent control record for milling duplicate parts. Another possible application of the tape is for telegraphing spare parts to any part of the world. The taped record can be converted into electrical impulses and sent via land or radio teletype lines to produce a similar tape recording at the other end. This tape can then be fed into a milling machine or a lathe to produce the desired spare part [80].

c. *Magnetic Tape*

This method possesses relatively high capacity and access speed. Like perforated tape, magnetic tape has been used in the memory units of simpler machines such as the milling machine recently developed by General Electric for the Giddings and Lewis Machine Tool Company. With this machine, relative movements of cutting tools and work can be controlled with great precision by means of electrical signals obtained from magnetic tape. With coordinated signals controlling each axis of motion, there is practically no limit to the complexity of the surfaces that can be accurately generated. The servo controls which translate signals into movements are adaptable to any basic type of machine tool.

To produce this magnetic tape, a skilled machinist performs the proper operations on the original piece of work. Each of his motions is converted into an electrical signal by means of selsyns, and these electrical signals are recorded on a multi-channel magnetic tape. When the tape is played back through the machine, it causes the machine to duplicate the original motions of the machinist, and thus produces a part identical to the one originally produced by the human operator.

Another technique of making a tape setup is to use points plotted from drawings. These are then interpolated and transformed into servo signals by a computer, after which the signals are recorded on tape. By this means it is possible to create machined shapes, such as machined turbine blades, that would be impossible to produce by using manual control of the machine [81]. There are several other methods which are still in the developmental stages. In one, a control follows the lines of a drawing directly, recording the motions on tape without setting up the machine. The other method operates from number information on the drawing, and causes digital information to be punched on a paper tape. This perforated tape is then used to produce a magnetic tape suitable for playback operation [82].

The magnetic tape may be played back up to 10,000 times without deterioration, it may be stored for a long period of time, and desired changes in the work cycle may be effected by erasing sections of the tape or splicing in new sections [83]. There is also probably no reason why these magnetic recordings could not be used to transmit corresponding electrical impulses to distant cities over commercial communications circuits, where they would produce similar magnetic recordings which would be used to manufacture duplicate parts at the distant locations.

Magnetic tape is also employed in the automatically-controlled lathes, milling machines, shapers, and other machine tools developed by the Turchan Follower Machine Company. In these machines, an electromagnetic sensing element is attached to the machine column in a fixed relationship with the cutting tool. The sensing element is connected to correcting elements and amplifiers, which in turn develop power for an electric motor which raises and lowers the table of the machine. If a template is used as the storage element, the sensing element traces the template and causes the cutting tool to reproduce the template contour on the work piece. The sensing element also acts as a correcting device and

counteracts any tendency of the tool to take a different path than the one prescribed for it. It is also possible to replace the sensing element and template by other storage devices such as punched cards, perforated tapes and magnetic tapes which can then feed the necessary information to the amplifiers [84].

Mention should also be made of the application of electrical signals from magnetic tape for operating valves, thermostats, pressure controls, motor controls and speed controls. In this way taped signals in a process sequence can repeat any pattern of temperatures, pressures, agitations and timed feeding of ingredients that has previously achieved a successful result. In addition, magnetic tape can be used to make a continuous correction in flowing or cycling processes. It can pick up a measurement at one point in the cycle, then apply a correction at another point some definite time interval later in the process. The tape is used in loop form and is erased and re-used each time around [85].

d. *Rotating Magnetic Drum*

The storage capacity of this device is limited only by its size, and it can store up to 100,000 characters. With the drum rotating at 3,000 revolutions per minute, the access time is only a few thousandths of a second.

e. *Delay-Line Storage Devices*

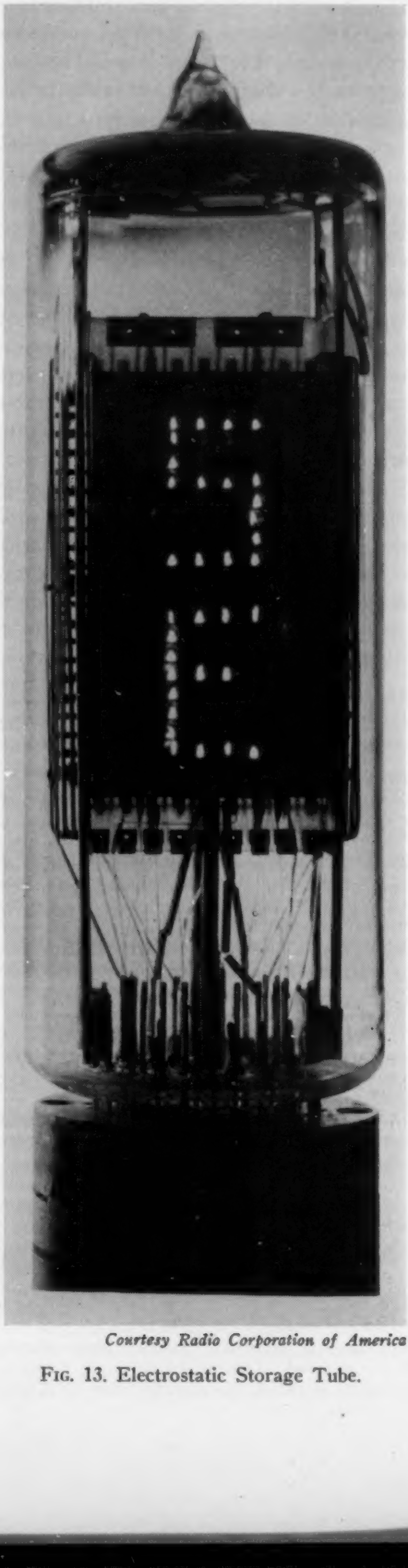
These devices generally consist of a combination of piezo-electric crystals and a column of mercury through which accoustical signals, representing information, are transmitted, amplified and fed back. This process is repeated several thousand times per second. An 18-inch mercury tube has a storage capacity of 1,344 binary digits. When the column is lengthened to increase the storage capacity, a familiar dilemma reappears, since the access time is then increased in direct proportion to the increase in capacity.

f. *Electrostatic Storage Tubes*

The information is recorded in these devices in the form of electrical charges on the face of tubes, which resemble the ordinary cathode-ray tube. Access is obtained by directing a stream of electrons to the desired element on the face of the tube. This device has the shortest access time of all, requiring only a few millionths of a second. However, these tubes are expensive and their storage capacity is limited to a maximum of 10,000 binary digits per tube. Consequently, electrostatic storage is used to store data required immediately by the control and arithmetic units, while magnetic drums are used to store information which is not needed at once [86, 87]. A recently developed electrostatic-type storage tube is shown in Figure 13.

g. *Toroidal Magnetic Cores*

These new devices are still in the process of development. They promise large capacity, fast access, and low cost. The storage is obtained in terms of the direction of magnetization of tiny toroidal magnetic cores. Access is obtained by



Courtesy Radio Corporation of America

FIG. 13. Electrostatic Storage Tube.

sending currents through selected windings linking these cores [88].

h. *Diode-Capacitor Memory*

The most recently reported development in information-storage devices utilize diodes and capacitors as the basic storage units. This system, developed by the National Bureau of Standards, employs two diodes and a capacitor for each digit stored. The capacitors provide memory by storing one of two voltage states, and the charge that gradually leaks away is periodically restored.

This system possesses high reliability, since the minimum signal is of the order of one volt, and need only be recognized as positive or negative in order for the information to be correctly interpreted. This offers a considerable advantage over the mercury memory and cathode-ray tube memory systems in which the value of the low-level signal output is extremely critical. In addition, the access time is extremely low, since this memory system can be designed to present an excess of 100,000 randomly located, 50-digit words per second to the computer. Thus, the storage system attains a speed corresponding to that of the arithmetic unit, with a resulting decrease in machine computation time [89].

Before leaving the subject of memory units, a rather unique application of the memory capacity of a digital computer will be mentioned. This is the Oettinger Automatic Translating Machine, which is designed to translate Russian into English. Each of the 33 letters of the Russian alphabet is given a code number from 01 to 33, and the memory unit is basically a Russian-English dictionary. The computer's control unit takes care of grammatical difficulties such as those introduced by Russian suffixes. The input section contains a Russian typewriter, while the output section contains an English typewriter. When Russian copy is placed in the input unit, an English translation appears in the output section. This translation is far from perfect, but it is in readable English [90].

3. *Arithmetic Unit*

This unit performs the operations of addition, subtraction, multiplication, and division. Combinations of these basic operations are used to perform more complex operations. This unit is also capable of distinguishing between positive, negative and zero values, and passing this information along to other parts of the computer [91].

4. *Control Unit*

The control or program unit is responsible for handling the three important questions—what, when, and where. It obtains its instructions from the storage unit and executes these instructions, one at a time, until the problem is completed. These instructions specify the operation which is to be performed, the location of the factors to be operated upon, and the place where the results are to be stored. The control unit sees that these instructions are carried out properly and that the correct operations are performed. A well designed control unit not only enables the computer to handle routine procedures, but also makes it possible for the computer to handle most of the exceptions to the standard procedure which are likely to be encountered.

The job of setting up the program is an extremely complex one, and many weeks or even months may be required to program a problem which may then require only a few hours of running time in the computer. The men who perform the task of programming these computers must know the machines, and possess a good knowledge of engineering and mathematics. They must also be familiar with the field of the problems. These problems might be in such diverse areas as meteorology, economics, languages, and aerodynamics. It is interesting to note that Harvard University has recently announced the establishment of a new course in computer data processing and programming leading toward a master's degree. This is the first offering of such a degree in an American university [92].

5. *Output Unit*

The answer to the problem appears in this unit. This answer may take the form of a punched card, perforated tape, magnetic recording, teleprinted sheet, or instructions conveyed by means of a digital converter to the effector or control elements of an automatic factory. Most of these output unit devices bear a marked resemblance to the corresponding tapes, teleprinters, and digital converters previously described in the paragraphs dealing with the input unit. Consequently, no descriptions of their operations need be given

here beyond calling attention to the rather obvious fact that when one of these devices is used in the output unit, its function is the reverse of the function it served when employed in the input unit. The following description of a machine developed by General Electric will serve to illustrate how the output unit of a digital computer can be used to control another machine such as an automatic punch press:

"Directions are fed to the punch press by an electronic digital computer. The computer reads a perforated card that contains information concerning the size, number and location of the holes to be punched. The punch press automatically positions the material to be perforated and performs its punching operations within an accuracy of a few thousandths of an inch" [93].

When a digital computer is employed to supervise an automatically-controlled process, it can be instructed and programmed to perform any desired series of complicated operations, and to react to emergencies in the same manner as would a skilled human operator, only thousands of times faster. It can be designed so that it will alter its own instructions in the light of its experiences, and will thus be capable of some degree of learning or profiting by experience. It can be designed to integrate the activities of the hundreds of individual analogue controllers present in the plant, while at the same time regulating the factory output, keeping track of inventory, and maintaining any other required accounting records [94].

Now that the basic features of both the analogue and the digital types of machines have been discussed, the question which naturally next arises concerns the relative advantages and disadvantages of each of these two types of computers. The following is then an attempt to answer this question by summarizing the outstanding features, advantages, and disadvantages of each type of computer.

It may be recalled that the analogue machine, as its name implies, is based upon a physical analogy to the type of problem which is to be solved. This problem need not be formulated explicitly, since the problem is implicit in the construction of the machine. Consequently, no special input or output equipment is required. This tends to make the analogue computer a relatively simple machine, and one which is cheaper to purchase and easier to operate than the digital machine. This probably explains why most computers used today to control industrial and military equipment employ the analogue principle.

The analogue machine also possesses the advantage of operating in "real time." Operations are carried out simultaneously, or in logical sequences, and the results obtained from each operation are used immediately in the next operation. Consequently, no memory provisions are required in the analogue computer. The computer continuously offers a solution of the problem, which is appropriate to the information which has entered the machine, and in this manner offers a solution which is always up to date. This property is very important in applications such as automatic control of airplanes and guided missiles [95].

On the other hand, analogue computers tend to be rather specialized and to lack flexibility, since their basic design permits them to solve only one type of problem. As the type of problem to be solved becomes more complex, the machine must also become more complicated. The corresponding mechanical play and electrical noise introduced by these additions produce errors which reduce the usefulness of extremely complex analogue computers. It is believed that the maximum useful size of an analogue computer has already been reached in the giant R.C.A. Typhoon Computer, built for studying the flight performances of guided missiles [96].

Another disadvantage of the analogue machine is that its results are approximate and are not absolutely repeatable. Any person familiar with the operation of a slide rule, which is a simple, analogue-type computer, will admit that the answer given

by this device represents at best only an "educated guess." Many analogue machines give results which are accurate to only one part in a hundred, while the best machines achieve an accuracy of only one part in ten thousand. Thus, the analogue computer obviously cannot be used where a high degree of precision is required [97].

The digital machine operates by counting and must be supplied by data in the form of numbers, usually expressed in the binary form. This necessitates a complicated input and output system which makes the machine slower, more complex and more expensive than the analogue computer, since the problem to be solved must be formulated explicitly for this machine. These disadvantages have tended to restrict the use of digital machines for control applications.

The digital machine is generally too complicated and elaborate for simple control tasks. However, as the task becomes more complicated, the digital machine begins to display its superiority. It is far more flexible than the analogue machine, and since it is free of the hazards of mechanical play and electrical noise found in complicated analogue computers, there is no limit to the complexity of the problem or process that can be solved or controlled by a digital computer.

The digital machines are relatively slow and usually do not operate in "real time." The time required to present a solution to a problem, such as the control of a guided missile, is frequently very long compared with the period in which significant changes can occur in the system being controlled.

Finally, the digital machine possesses the advantage that it can be made as precise as desired. To obtain increased accuracy, the builder need only increase the number of significant figures carried by the machine. Of course, this tends to reduce the speed of the machine. Digital computers are employed mainly for solving complicated control problems involving a large amount of data and requiring an extremely high degree of accuracy, regardless of cost or time.

It must be emphasized that the digital computers which will be used for control of automatic factories will not be exactly the same as the large-scale general computers now employed in research laboratories. These latter computers are capable of solving partial differential equations, and they employ thousands of tubes and crystal diodes. On the other hand, many of the factory computers will be relatively simple devices, employing comparatively few tubes and diodes, and will be capable of doing little more than keeping records and making simple routine decisions. A recent article has drawn a picture of how such a computer would control the operations involved in the manufacture and assembly of an electronic chassis:

"In the memory of a central digital computer, all the data and rules needed to perform the functions would be stored. Components of the same class would be automatically sorted. By measuring their mechanical or electrical characteristics—and converting them to numbers for comparison with sets of numbers stored in its memory—the computer would sort components and feed them into special containers. . . .

"Stored also in the computer's memory would be dimensions of the chassis, with position and size of holes required. From this information, it would initiate operation of either a milling machine or punch press, and from return pulses the computer would know at all times displacement of the machine's table or size of its punch, thereby controlling its operation.

"Standard machines would be used with the addition of sufficient pulse generating equipment. Thus all information could be deduced by counting pulses or detecting the presence or absence of voltage levels. In the same way, coordinates could be determined for the placement of electronic components or for assembly of circuits. . . .

"When the chassis is assembled, the computer would find in its memory certain inspection criteria. . . . With proper sensing equipment, the computer would determine acceptance or rejection of a chassis. The computer would also keep necessary records: number of good and bad chassis, reasons for rejections, shortages of components, and so on.

"Other operations computers might do are: stop production when the number of chassis reach a predetermined quantity, calculating this quantity from relative speeds of production and other pertinent data, automatically initiating assembly of the next chassis, possibly for a radically differ-

ent system; causing all operations to cease by sensing emergencies like breakdowns, botttlenecks, or lack of parts. In effect, then, the computer could do anything expressable as simple rules as long as it could sense the rules" [98].

Where the product being manufactured is relatively simple and uniform, the introduction of automation is comparatively simple. The situations which introduce problems are those in which relatively small quantities of complicated products are turned out in a non-continuous batch process.

One method of solving these problems is to employ computers programmed by perforated or magnetic tapes to control the batch processes. Another way of solving these problems is to convert the batch process into a continuous one. For example, some steel firms are now producing continuous castings in an automatic process. A recent publication reports:

"Hardly a day goes by without an announcement that a continuous process has been developed to produce some commodity that has been chained heretofore to batch or piece work methods. These frequent announcements reflect the tremendous amount of engineering talent that has been assigned to the development and improvement of continuous process (methods). . . . Continuous process is the ultimate stage of mechanization (automation)" [99].

In applying automation to complicated production processes, it will probably be necessary to rethink the entire process, since the conventional process will probably not lend itself readily to automation. Human beings are creatures of habit. When a new device comes along to replace an older one, the natural tendency is to attempt to employ this new device in a manner similar to that of the older one. For example, when factories were powered by steam engines, there was usually one large steam engine which supplied all the mechanical energy for the entire factory. The single steam engine was connected with the various machines by a criss-crossing network of belts and pulleys. This design was logical, since it had been found to be inefficient and uneconomical to employ smaller steam engines to power each individual machine. After the electric motor was invented and developed, the large steam engines were pulled out and equally large electric motors were set in their places. The belts and pulleys still remained. There was a considerable lapse of time before it was clearly seen that the introduction of the electric motor meant that the factory would have to be redesigned; that the belts and pulleys could now be eliminated, and that the use of small electric motors to power each machine individually would result in a higher degree of efficiency than could be obtained by the old way of distributing energy.

Another illustration of this all-too-human tendency to think of the new only in terms of the old may be observed in the evolution of the automobile. The early models really lived up to the name of horseless carriage. These vehicles differed little in basic design from the older, horse-drawn vehicles, except for the obvious fact that their motive power was supplied by an engine instead of by a horse. In fact, many an early model was equipped with an imitation horse head attached to the front of the vehicle, and carried in addition, a completely non-functional buggy-whip holder. It took many years for the automobile to discard some of the trappings associated with horse-drawn vehicles. Even today there are people who are opposed to the placement of engines in the rear of automotive vehicles. This opposition is based upon the feeling that that is not the right place to install the device whose function is to replace a horse.

A similar type of error may be found in the attempts of some engineers and designers in the steel, automobile and electronic industries to graft or superimpose the newer techniques of automation upon production processes which were originally designed to be carried out by human beings. Before automation can be profitably employed, it will usually be necessary to do considerable "rethinking." This may conceivably involve a complete change in the

design of the equipment and the product, in order to make it possible to manufacture it on an automatic production line.

What has just been said, was established and susbtantiated in a recently published article by Diebold, one of the originators of the term automation. In this article, the writer stated:

> "It is a mistake to think of the new technology as providing gadgets which when attached to present machines and processes allow automatic operation. . . . The full force of the new technology cannot be realized as long as we think solely in terms of control. The redesigning of products and processes, the analysis in terms of functions rather than of the steps now being performed, the rethinking of the entire operation—all these infinitely difficult tasks must be performed before business can in any real way begin to take advantage of the Aladdin's Lamp which technology holds forth" [100].

To illustrate the redesigning problem suggested by Diebold, let us consider the task of manufacturing radio receivers and similar electronic equipment on an automatic production line. Conventional resistors, capacitors, transformers, choke coils and other components usually found in electronic devices did not lend themselves readily to automatic assembly operations. In addition, the job of wiring or interconnecting these components with each other, using the usual "inverted cake pan" assembly techniques, could not be performed automatically, especially if conventional wiring techniques were employed. Obviously a good deal of rethinking and redesigning were required before automation techniques could begin to be applied to the production of electronic equipment.

The wiring problem was easily solved by throwing away conventional wiring systems and substituting printed and etched circuits, employing techniques developed during the past decade. However, the problem of redesigning the basic components was not solved quite as easily.

A solution to the problem was announced in late 1953 by the Bureau of Standards. It is known technically as the Modular Design of Electronics or MDE System, but is more commonly known as Project Tinkertoy [101]. Associated with this new system of design is a corresponding production system known as MPE—Mechanized Production of Electronics.

The MDE System is based upon a series of modules, each containing from four to six small, notched, ceramic wafers or building blocks. The corresponding MPE Production technique bears many points of resemblance to an automatic electronic production process known as the Electronic Circuit Making Equipment, which was developed in England in the 1940's by John Sargrove, Ltd. [102].

Each module contains the circuits associated with a single electronic stage; and a number of modules may be combined by machines to form sub-assemblies designed to generate or amplify signals, count, and perform other functions usually associated with electronic equipment. Circuit elements are printed or mounted on the wafers by means of automatic machinery. In place of wire, conducting paints are employed; resistors are replaced by small pieces of adhesive resistance tape, and the components are joined together by an automatic dip-soldering process. The physical and electrical characteristics of the parts mounted on the wafers are tested by automatic testing machines located on the production line. These testing machines are controlled by punched cards, which cause the testing machines to set up the correct test circuits for each task.

The ceramic wafers, ceramic capacitors, and adhesive tape resistors are produced in quantity from the raw materials. In fact, all of the large-quantity parts are produced by the production line except for the vacuum tubes. The basic parts are then fed into the production line where sections of certain wafers and capacitors are silver-plated, circuits are printed on other wafers, conducting surfaces and leads are applied to capacitors, wafer and capacitor bodies are heat cured, and the circuits are inspected. Control of quality is maintained, as pre-

viously described, by means of automatic inspecting machines which are controlled by information supplied by punched cards [103].

Each wafer may hold as many as two capacitors or two tape resistors on each side. Other wafers may contain tube sockets, coils, potentiometers, or crystals. The necessary soldering operations are performed automatically by means of induction heating and dip tinning.

A machine then assemblies four to six wafers to form a module. The correct interconnections between the wafers are completed by means of riser wires which are automatically soldered to notches on the wafers. The riser wires are then clipped and the completed module is tested.

In the final assembly operation, groups of modules are mounted on copper-clad base plates. The copper surfaces of the plates contain etched circuits to which the riser wires of the modules are connected to form a complete electronic circuit for a relatively simple device such as a radio receiver. For more complicated pieces of equipment, it may be necessary to connect several plate assemblies.

It should again be emphasized that there is 100 per cent physical and electrical automatic inspection during each of these production stages. Wafers are gauged for proper thickness, while printed circuits, capacitors, and resistors are measured and compared with standards, both before and after assembly, in accordance with inspection instructions contained on punched cards prepared by the designers. These cards accompany the wafers, modules and base plate assemblies through the production process [104].

In addition to the more obvious advantages of automatic production, such as greatly expanded production capacity, the MDE System reduces lead time in production by 75 percent, makes possible a rapid conversion from civilian to military production, and due to the flexibility of the building-block assembly technique, permits quick and convenient changes in the design of the product [105, 106].

Another advantage of this MDE System is that the electronic devices produced in this manner are relatively easy to repair. Due to the low cost of production, the entire sub-assembly can be replaced by a new one after the defective stage has been localized and identified. It is therefore not necessary for the repairman to go through the time-consuming process of replacing individual resistors and capacitors. Ease of repair is an important factor today in a period in which devices of ever-increasing complexity are being placed on the market faster than technicians can be trained to service them. A recent editorial in a publication specializing in electronics has called attention to this problem of servicing the electronic equipment turned out by automatic production lines:

> "We are concerned what will happen if our robot engineers do not keep a constant vivid servicing picture before them. The engineer's temptation to build an efficient automation production line is a most powerful and compelling lure. He must sacrifice many things to achieve speed in assembling . . . of the final assembled chassis.
>
> "It is only natural that he may not—in such a complex undertaking—give too much thought to the service technician, who later on must repair and put in order even the best engineered receiver. Will all the parts be accessible readily? Can they be replaced in a reasonable amount of time —or will it be necessary to tear the whole chassis apart? Will they be so difficult to service that the average servicing technician will refuse point blank to touch them? . . . In this last instance the public will learn how to avoid buying such unserviceable receivers.
>
> "May we therefore, earnestly impress our automation engineering fraternity to give a great deal of consideration to the servicing phase and its problems—before automation is finally frozen irrevocably" [107].

By now it should be apparent that the automatic production of electronic devices by means of the modular technique which has just been described differs considerably from the present-day conventional methods of producing electronic equipment. Similar fundamental design changes and "rethinking" will be required in other indus-

tries before true automation can be achieved.

How long will it take for techniques of automation such as these to gain general acceptance and adoption by our large industries? Weiner hazards a rough estimate that, short of violent political changes or a great war, it will take this new technique ten to twenty years to come into its own. He states that we are now as far along in the process of developing automatic control machines as we were in the development of radar in 1939. The emergency of the Battle of Britain accelerated the development of radar, with the result that the normal progress of decades was accomplished in two years. If this country were to be involved in another great war, the needs of labor replacement would be likely to have a similar effect upon the development of the automatic factory, and the automatic age would probably be in full swing within two to five years [108].

Another writer, Berkeley, has advanced a number of reasons for believing that the age of automation will soon be upon us. To support these conclusions he has brought out the following facts:

1. The techniques for making highly competent robots have already been highly developed.
2. The cost of many automatic devices is relatively low. For example, a photoelectric device is cheap and performs many tasks better than human eyes can.
3. The process of automation should be speeded up by the fact that there is considerable profit in substituting machines in the place of men.
4. Additional rapid advances in this field may be anticipated because of the fact that automation is a fascinating technique which has attracted many competent men from other fields [109].

What will be the economic and social consequences of the changes in production techniques brought about by automation? Some writers have taken a pessimistic view of the benefits automation may bring to our civilization, while other writers look forward optimistically to a brighter and braver new world. In the words of one of these writers:

"Important new inventions are traditionally held to presage the dawn of a new era; they also mark the twilight of an old. For some observers they contain promise: for others, fear" [110].

Let us first note some of the statements made by those who maintain a somewhat pessimistic point of view. Weiner for example, states:

"We can expect an abrupt and final cessation of the demand for the type of factory labor performing purely repetitive tasks. In the long run, the deadly uninteresting nature of the repetitive task may make this a good thing and the source of leisure necessary for man's full cultural development. It may also produce cultural results as trivial and wasteful as the greater part of those so far obtained from the radio and the movies.

"Be that as it may, the intermediate period of the introduction of the new means . . . will lead to an immediate transitional period of disastrous confusion. . . . Let us remember that the automatic machine . . . is the precise economic equivalent of slave labor. Any labor which competes with slave labor must accept the economic conditions of slave labor. It is perfectly clear that this will produce an unemployment situation, in comparison with which . . . the depression of the thirties will seem a pleasant joke. This depression will ruin many industries—possibly even the industries which have taken advantage of the new potentialities. . . .

"Thus the new industrial revolution is a two-edged sword. It may be used for the benefit of humanity, but only if humanity survives long enough to enter a period in which such a benefit is possible. It may also be used to destroy humanity, and if it is not used intelligently it can go very far in that direction" [111].

Weiner then goes on to warn against the dangers of using computing machines to make major decisions on questions of national policy. After describing briefly the newly developed theory of games, which could lead to the development of such a governing machine, he states:

"I say that the machine's danger to society is not from the machine itself but from what man makes of it. . . . Any machine constructed for the purpose of making decisions, if it does not possess the power of learning, will be completely literal-minded. Woe to us if we let it decide our conduct! . . . On the other hand, the machine . . . which can learn and make decisions on the basis of its learning, will in no way be obliged to make such decisions as we should have made, or will be acceptable to us. For the man who is not aware of this, to throw the problem of his responsibility on the machine, whether it can learn or not, is to cast his responsibility to the winds, and to find it coming back seated on the whirlwind" [112].

Berkeley also echoes Weiner's concern regarding the potential dangers of robot machines in the following words:

"It is not only that life itself seems more greatly endangered than ever by the possible use of robot weapons in warfare. It is also that people are endangered economically—in their jobs and pocketbooks. The application of robot machines in industry plainly increases the hazards of unemployment.

"Thousands of jobs have already been lost to the robots. Consider what happens when automatic machinery is used, for example in making cigarettes, glass bottles and shoes, or for operating dial-telephone systems. In 1949 when Boston became the seventh American city where long-distance calls were handled automatically by a system known as operator toll dialing . . . 450 toll operators received their termination notices. . . .

"It may be argued that unemployment caused by the robot machine is just another kind of technological unemployment. This is true, in a sense, but the technological unemployment which will result from the wide introduction of robots may be very different in quality and degrees from any so far experienced. Similarly, it may be argued that there will always be work for large numbers of people in making and servicing robot machines. This in doubtful. If a present-day robot factory can roll hot steel, a future robot factory can produce little robots on an automatic assembly line" [113].

A typical layman's attitude toward the potential menace of automatic machinery is refletced in the following statement:

". . . but there's no question about machines; they are getting scarier and scarier. . . . Maybe colleges should amend their curricula to leave out obviously obsolete logic and philosophy and insert instead a course in repairing mechanical brains. It would give human beings at least some place in the new order" [114].

The psychological effects of automation upon the general public and upon the production workers are not to be lightly discounted. In New York City, the management of two large office buildings, after having installed automatic elevators, decided to hire operators anyhow, saying: "We find automatic elevators a little cold" [115]. In a recently completed chemical plant, the engineers decided to add to certain control apparatus several control knobs that actually weren't needed. The reasons given were: "We had to give the control operator enough to do" [116]. The Ford Motor Company has found it necessary to produce a moving picture entitled "Technique for Tomorrow," specifically designed to sell the concept of the automatic factory to its workers. It explains to the man on the production line how his future will be affected by the automation production line of tomorrow. It develops the idea that automation means letting the machines do all the difficult and tedious work and saving men for better and more interesting jobs [117]. Those who are interested in reading a well-written and rather pessimistic fictional account of what life may be like in the coming era of automation will find Vonnegut's novel "Player Piano" extremely interesting [118].

Another possible effect of automation may be to encourage big corporations and large governmental agencies to become even bigger. At present, there is an optimum size for a business or governmental administration. When this size is exceeded, the law of diminishing returns sets in, and the operations become too unwieldy to compete with those of smaller and better integrated units. It becomes almost impossible for the men who make the plans to know all of the facts bearing upon their decisions, or to calculate all of the consequences likely to result from the adoption of a given course of action. The use of automatic machinery, computers, information processing machines, and governing machines may make it possible to increase the optimum size of many of these already immense organizations [119]. Whether this growth in size of governmental and industrial organizations produced by automation will produce outcomes that are good or bad for the general public welfare is difficult to predict at the present time.

There are also those who fear that automation will encourage the concentration of political power. They argue that automation may result in the establishment of authoritarian controls over all major institutions, under the pretense of promoting smoother operation of industry and society.

Accompanying this is the fear that expansion of automatic technology will make life duller and poorer by reducing opportunities for individual creativeness and by eliminating the pride of workmanship and the need for making sensitive qualitative discriminations [120]. The fear is expressed that automatization and large-scale mass production will remove the last traces of human creativeness and variety from man's products.

Perhaps this picture of the future will appear somewhat less gloomy after it is pointed out that the advent of automation does not necessarily mean that automatic machines will completely replace human beings in every line of work. Automation techniques will be adopted when they either make possible some desirable results that could not be accomplished in any other way, or else make it possible to accomplish some task, now being performed by older methods, at a net savings in cash [121]. While machines show superiority to humans with respect to functions such as speed, power, computation, simultaneous operations, and short-term memory, human beings still maintain superiority in certain other functions, such as general detection and perception, judgment, induction, improvisation and long-term memory [122]. As long as human being possess these superior qualifications, there will be a place for them in industry. It should, however, be pointed out that while machines can be modified, redesigned and improved, there are fixed limits to the capabilities of human beings. The basic characteristics of the human species have not changed for thousands of years, and will not change significantly for many generations to come. Meanwhile men can only be selected and trained to use what they have with maximum efficiency; their limits are firmly fixed [123].

Nevertheless, it must be conceded that there will remain trades into which the new industrial revolution will not penetrate. This is due to the relatively high cost of control machines employed in small industries, and possibly because the work is too varied to permit automatic control. In other words, automatization will probably never be complete in these fields because of the relatively high cost of converting to automatically-controlled equipment, or because of the inherent limitations of an inflexible machine designed to operate according to a fixed system of rules [124]. It is difficult to visualize automatic devices replacing the local grocer or garage mechanic, though it is easy to see these devices employed by wholesale groceries and automobile manufacturing establishments [125]. The postman will undoubtedly continue for a long time to ring doorbells, obtain signatures, collect postage due and perform a host of additional functions that would baffle any machine we can produce within the foreseeable future.

It is now time to examine some of the statements and opinions of those who display optimistic and hopeful reactions toward the approach of the era of automation.

A geographer, Osborn, has pointed out that automation decreases both the amount of space required, and the size of the labor force needed to turn out a given amount of product. This tends to free the manufacturer from the controlling influences of land and labor, and could conceivably lead to a pattern of decentralization from major urban areas. The resulting industrial dispersion would probably prove to be beneficial in many ways, and would be particularly important from the point of view of aiding our military defenses against the possibility of atomic attack [126].

With respect to the likelihood of technological unemployment resulting from the introduction of automatic machinery, many writers refuse to go along with the pessimistic views previously cited. For example, it is pointed out by one writer that when Hargreaves built the first practical multiple spindle machine in 1767, a mob of spinners, fearful that this invention meant loss of their jobs, attacked his mill and

destroyed the equipment. Yet, for the next 100 years, England prospered greatly, the labor force both in the textile and textile machinery industry expanded, and wage rates were tripled [127]. A similar point of view is maintained by a second writer who asks:

"Will automatic factories mean vast numbers of unemployed? The answer to that might be found in another question: Did the original coming of mass production put men out of work? Look at industrial payrolls today. The fact is, manpower is short, and every man saved one place will be used someplace else. Skills and people capable of learning skills are in greater demand than ever" [128].

A third writer calls attention to the fact that though the continuous rolling mill eliminated almost all the manual jobs of the old hand steel mill, it created new jobs in the steel industry because of the increased demand for the improved steel turned out by these new mills. As a result, steel mills which employed 424,000 men in 1923, employed 651,700 men in 1952. In addition, other industries that had expanded because of the supply of better steel, also hired additional men. Finally, the continuous rolling mill resulted in better working conditions for the men who made steel. The writer then goes on to state:

"Experience has shown that instead of creating unemployment, automation tends to create jobs. . . . It is true that automation will change the character of our labor force, replacing unskilled labor with skilled. But the change will not be abrupt and it will benefit the whole population" [129].

While the worker may not be placed in the ranks of the unemployed by the introduction of automatic machinery, the nature of his work will probably change radically. In general, these changes will tend to free him from the uninteresting repetitive jobs of the production line and assign him to tasks of a supervisory or maintenance nature. An illustration of this trend may be noted in the automated atomic plants at Oak Ridge. Only thirty people are needed to operate each plant, but the services of hundreds of men are required for proper maintenance of the automatic equipment installed in each plant [130].

These shifts in the nature of the duties of workers from production to maintenance work will require the establishment of broad, in-service training programs designed to upgrade the individual worker and give him increased skills commensurate with his increased responsibilities. This point has been clearly brought out in the following recent statement by the president of the Chrysler Division of the Chrysler Corporation:

"Automation will shift the work load from production to maintenance work. The reason is that the automatic assembly line is technically complex. . . . A big program of preventive maintenance is probably the only way to keep the automated plant from burning up its profits. Consequently, automation in some plants could require more labor than it saves on production man-hours.

"The increased burden of maintenance will certainly create shortages in some areas. . . . One possible solution is a broad training program that could turn production workers into skilled electricians, millwrights and machine repairmen" [131].

The same basic points were established in another recently published article:

"Even in the most robotized of the automatic factories, there will be many men, and they will have interesting and responsible jobs. They will be freed from the tiring, nerve-racking or even boring jobs of today's mass manufacturing. To win this freedom, however, they will have to upgrade themselves in skill and sophistication. The new controllers and instruments will call for a higher level of precision of repair and maintenance. A fifty thousand dollar controller cannot be hit with a hammer if the shaft doesn't fit into the hole on the first try. Men who have heretofore thought of electronic equipment as merely a metal chassis with tubes, will become conversant with switching, flip-flop, peaking, and other circuits. They will have to judge when to repair and when to throw away rather than stop production. . . .

"These robots are not hurting the workmen—they merely coax him, none too gently, into taking more responsible jobs, making bigger decisions, studying and using his mind as well as his hands" [132].

Another writer, Leontief, maintains a very similar point of view. He states:

"Man has all but ceased to be a lifter and mover and has become primarily a starter and stopper, a setter and assembler and repairer. With the introduction of self-controlled machinery, his direct participation in the process of production will be narrowed even further. The starter and

stopper will disappear first, the setter and assembler will go next. The trouble-shooter and repairman, of course, will keep their jobs for a long time to come; the need for them will even increase, for the delicate and complicated equipment of automatic control will require constant expert care. . . .

"All this inevitably will change the character of our labor force. The proportion of unskilled labor has already declined greatly in recent decades; it is down to less than 20 per cent. . . . Now we shall probably see an accelerated rise in the proportion of skilled workers, clerks, and professional personnel, who already make up 42 per cent of our working population. . . .

"Will the machine-press operator be able to earn his $3,000 when an automatic controlling device takes over his job? The answer must depend in part on the speed with which the labor force is able to train and retrain itself. If such upgrading were to fall behind the demands of the changing technology, semi-skilled and unskilled workers certainly would suffer unemployment, or at least sharply reduced earning power. The experience of the last twenty years however has underlined the flexibility of U. S. workmen. . . . They have been quick to take to vocational training for new jobs. . . . The danger of technological unemployment should be even smaller in the foreseeable future than it was at the end of the 19th century.

"While the increase in productivity need not lead to involuntary idleness, it certainly does result in a steady reduction in the number of years and hours than an average American spends at making his living. . . . In other words we have chosen to spend more and more of our ever-increasing production potential on leisure. . . . In the future, even more than in the past, the increased productivity of the American economy will be enjoyed as additional leisure" [133].

Leontief also calls attention to the new trend in the direction of applying automation techniques in underdeveloped regions of the world where the lack of a skilled labor force has been a major obstacle to rapid industrialization. He cites the oil refineries of the Near East, the new steel plants of Brazil, and the new fertilizer plants of India, as examples of how the techniques of automation can compensate for the scarcity of highly skilled labor and can help shorten the process of improving the economy of the so-called backward regions of the world [134].

Even the humble office worker appears to be in no immediate danger of being replaced by automatic machines, despite a recent statement by C. B. Jolliffe, technical director of the Radio Corporation of America, in which he painted a picture of what the automated business office of the future may look like. In this office, automatic machines would maintain complicated stock records, prepare statements, handle debit and credit accounts, and transmit this information to distantly located executives via facsimile or closed-circuit television [135]. In contrast, a considerably more optimistic attitude toward the future employment prospects of office personnel is maintained in a report recently issued by the U. S. Department of Labor. This report points out that in April 1954, nearly eight million men and women were employed in clerical work. This represents an increase of 64 per cent over 1940. The report also predicts that this expansion of clerical employment will continue, stating:

"Despite the machines, everything from automatic files to automatic thinkers, the human office worker is still in great demand" [136].

Unfortunately, because of the many factors involved, we are at present in no position to calculate with exactness the future effects of automation upon employment. It is impossible at this time to make a final decision between the arguments of the optimists and those of the pessimists regarding the future employment situation. We do know that while the introduction of automatic machinery might benefit labor, it would not necessarily have to do so. There is always a possibility of severe technological unemployment. However, unemployment is not the inevitable concomitant of automation, and intelligent planning can reduce the probability of its occurence. In the words of one writer who has analyzed this problem: "The United States appears to be capable of adjusting itself to a major industrial reorganization without uprooting its basic patterns of living. Large-scale technological unemployment may be a more acute danger in other countries, but the problem is not insurmountable, and measures to circumvent, or to mitigate it, can be taken" [137].

The same writer also concludes that the major consequences of the applications of large-scale automatic technology are likely to be a tremendous increase in industrial productivity, elevation of quality standards of products, reduction of working hours, and elimination of much brutalizing drudgery. He is of the opinion that, in the main, these developments of automation will tend to promote human welfare [138].

Mention has previously been made of the fact that there are people who fear that automation may produce undesirable aftereffects upon our culture, and may harmfully restrict the development of individualism and of the human spirit. Some see something sinister and menacing in the development of robot-like computing mechanisms capable of duplicating or even exceeding human functions. They suggest that there is always the possibility that at some future date these machines may turn against their human masters and take over the management of human affairs. They express the fear that automatic machines may develop wills, desires, and unpleasant foibles of their own, as did the robots in Capek's famous play "R.U.R." [139]. Others gloomily see men becoming narrow specialists whose main functions will be serving and tending the automatic machines. They fear that automatic technology may impoverish the quality of human life, robbing it of opportunities for individual creation and pride of workmanship. Consequently, they condemn the materialism of an age of automation and demand the return to the spiritual values of earlier and simpler civilizations [140].

In direct opposition to these pessimistic views, other writers point out the fact that compared with a human brain, the mechanical brain is rudimentary. The operation of the computing machine corresponds to that of the spinal cord and thalamus, which together control most human motions. It is where the spinal cord and thalamus leave off, that the human brain begins to exercise its remarkable powers and puts the machine far behind [141]. While the mechanical brain is thousands of times faster than the human brain, its memory is relatively poor, and it lacks the one important attribute of human thinking, namely imagination [142].

In answer to the argument that men may develop an inferiority complex because some computing machines can surpass human capabilities in certain tasks governed by logical rules, it is pointed out that it was not difficult for men to make the psychological adjustment to the fact that a steam-shovel can lift a load that no man could budge. Just as men have readily granted the superiority of machinery to human muscles, so men will readily concede that in certain respects a human being cannot compete with a computing machine. The factor which will prevent men from developing a feeling of inferiority toward any of these muscle-saving or brain-saving machines is the knowledge that men have designed these machines, men have built them and men have given these machines their operating instructions [143].

Consequently, the optimists maintain that we need have no fear of automatic machines. They will not make obsolete modern man and his brain, but will continue to function merely as tools for the purpose of aiding and enabling men to reach higher levels of attainment. These machines can direct complicated tasks at high speeds, but their performance of these tasks will be only as efficient as the minds of the human beings who planned and designed the machines [144].

Since automatic controllers possess no intelligence except that which the genius of human minds has built into them, the design of automatic systems to accomplish tasks that have no precedent in experience will challenge to the utmost the imagination, inventiveness, and ingenuity of man. The installation of automatic equipment will not tend to eliminate human thinking, but will, to the contrary create a need for better and clearer thinking. Because the maintenance and operation of these systems calls for clarity of mind and technical knowl-

edge, the quality of personnel requirements will be raised to new and higher levels, rather than lowered. Thus, man's destiny will continue to remain in his own hands.

With respect to the fear that automation will impoverish the quality of human life, it is pointed out that this sort of argument has been advanced many times in the past by those who have been opposed to the advances of modern technology, who condemn the materialism of the current age, and who would like to turn back the hands of the clock in the forelorn hope of rediscovering the spiritual values of a non-existent golden age of the past. It is also pointed out that there is no special virtue in poverty, and that great cultural achievements can only be attained by societies in which at least part of the population is above a mere subsistence level of existence. It is quite possible that by raising the standards of living, automation may also help raise standards of culture. The argument is advanced that there is no reason to believe that liberation from drudgery and toil should be accompanied by the elimination of creative thought and pride in workmanship. They call attention to the fact that with the aid of modern automatic controls, it will be possible for machine-made products, such as textiles, to equal the beauty, quality and individuality of "hand-made" products [145]. Such products and materials, once limited to the few because of excessively-high production costs, would now become available to many people who possess good taste but lean pocketbooks. The conclusion is reached that the fear that the application of automation means the loss of cultural and spiritual values is baseless and entirely without foundation [146].

We have now reached the point where we can consider what our educational system can do to ease the transition into the coming age of automation. In the area of higher education, the engineering schools will be confronted with the problem of organizing a new kind of profession—that of control-system engineering. This type of engineer cannot be produced by training a man in isolated areas such as electronics, thermodynamics and mathematics, which are customarily given in separately organized departments of a college. Controls engineering requires a new synthesis and integration of studies in the areas of mathematics, physics, chemistry, electronics, servomechanisms, and computational techniques, rather than the acquisition of a conglomerate smattering of knowledge in each of these fields [147].

It has been said that one of the most serious problems in automation has been the lack of engineers possessing an overall understanding of control systems and of the plants and processes to which they are to be applied. There are many qualified engineering specialists, but their specialization hampers rather than assists the integration of the plant with its controls. The systems engineer must be able to regard the entire plant as one huge instrument, whose various sections, whether electronic, pneumatic or cybernetic in nature, are merely component parts. Such a view requires great breadth of vision, freedom from specialization, and a good deal of common sense. The task of organizing a curriculum for developing this sort of systems engineer is indeed a formidable and challenging one [148].

Educators associated with the various areas of adult education will also encounter new, and often perplexing problems. It has previously been stated that one of the greatest obstacles to the development of automatic production is the lack of information about what can be done. What can be done at the present time is far ahead of what is actually being done. There will soon be a demand for courses designed to acquaint those engaged in industrial management capacities, from corporation president down to foreman, with the basic principles of automation. The executive of tomorrow will want to know what his systems engineer means when he talks about feedback, process lags, and time constants [149]. Specialists in adult education

will also face the task of organizing courses designed to upgrade workers replaced by automatic machines. These courses must help accomplish the task of turning production workers into supervisory and maintenance personnel.

A tremendous amount of work must be done by educators who are on the secondary school level. In order that they may give young people intelligent guidance, vocational counselors will find it necessary to analyze the probable effects of automation upon various occupational areas. Vocational curricula, particularly in the machinist and clerical fields, will require considerable revision. There will probably be an increased emphasis upon the development of flexibility and broad understandings as opposed to the narrow specialization of today, and upon the education of supervisory and maintenance personnel, rather than the training of production workers.

A second important problem confronting secondary school educators will be the increased emphasis placed upon the development of hobbies and worthwhile leisure time activities. The significance of these new developments, as applied to a specific secondary school area such as industrial arts education, has been brought out recently in the following excerpt from an article by a specialist in the field of industrial arts education:

> "Due to the spectacular growth in the use of electronic controls . . . there will be some dislocation of workers, and some unemployment as a result, but in general, it will probably end with still further reduction in working hours for all. This means, then, still more leisure time for the average man. And for industrial arts, this means a continued and greater stress on avocational and hobby activities. There is no question but that it should be one of the most important objectives to find, developed, and encourage a desirable hobby activity for every pupil who passes through an industrial arts class" [150].

This statement is probably equally applicable to teachers of science and other secondary school subject matter areas.

High school science and shop departments will probably find students showing increased interest in their offerings, particularly in the areas of physics, physical science, and electricity. There will probably be a similar increased interest in some of the offerings of the mathematics department. Many of the larger secondary schools located in industrial areas will probably be requested to set up specialized courses dealing with electronic controls and servomechanisms.

Some preliminary work has already been accomplished in the area of secondary-school electronics, but the servo-mechanism field is virtually undeveloped at the secondary school level, although it must be acknowledged that considerable progress has been made on a somewhat higher level in this area by educators associated with the technical schools of the armed forces [151]. One book on the secondary school level has recently been published which explains in simple terms how servos and synchros operate, and which also describes simple experiments with servo-mechanisms [152]. One manufacturer has come out with a servo board, capable of being utilized for setting up flexible, experimental servo, computer, and regulator assemblies [153]. It is apparent that here is an opportunity for technical and vocational educators to develop new curricular materials, laboratory exercises, and teaching aids, in a comparatively unexplored, but increasingly important, area of knowledge.

Probably the most important problem confronting the secondary school educator is that of reducing the growing gap between common knowledge and the achievements of science and technology. It is imperative that all young people acquire an intelligent understanding of the basic principles and implications of atomic energy, jet propulsion, and automation. One educator has summarized this as follows:

> "Time was when the average youth could at least grasp the essential theory of most of the machines and devices with which he came in contact. But how much does the average person know about these new developments? Apparently very little, and it is a bit frightening. Society seems to be approaching a situation where a few superscientists are the only ones who will under-

stand these mechanical and scientific giants. That much power and influence in the hands of a limited group could be dangerous and so it appears that all education . . . must attempt to close the gap to make the average person intelligent about these new and startling developments"[154].

No one is quite certain how this should be done, but somewhere in the general education of all young people they must be given the time and opportunity to experiment with, and to learn about these important scientific and technological principles and developments, and to evaluate them in terms of their probable effects upon the world of tomorrow in which these young people will live. An attempt of this sort will require a type of "combined operations" approach which will cut across departmental and subject matter boundaries, and will employ the coordinated and integrated efforts of science, social science, industrial arts, and vocational teachers.

Many educators have been going along complacently accepting the new developments in automation, electronics and communications, in the mistaken belief that the total result of these innovations will be to make things bigger, faster, or better. The fact that they have failed to realize is that the world of 1980 will probably be as different from that of today, as our world differs from the world of colonial America. Think of the changes in our culture and ways of living which have been occuring at an increasingly accelerated rate during the the past thirty years, as a result of the development of the automobile, the airplane, motion pictures, radio, and television. Then try to visualize what the next thirty years may bring. As educators, we shall be failing our obligations toward our students if we permit them to leave school believing that the world of tomorrow will be very similar to our world of today, except that things will be bigger, faster, and better.

We are neither seers nor prophets, and certainly no one expects us to foresee all that the future may bring. However, "coming events cast their shadows before". It would certainly not be inappropriate for teachers and students, working together, to analyze current trends and developments in science and technology, and to attempt to extrapolate from what is known of the world of today, a probable picture of the world of tomorrow. This was probably what Berkson had in mind when he wrote:

". . . Children are being prepared to live in their own generation . . . not in their parents' or grandparents'. It is reasonable to say that the school should always endeavor to be at least a generation in advance of the community as a whole. So to plan education is particularly urgent in our day of great and drastic social change. Relating education to the needs of the society envisaged as coming into being does not imply indulging in vague prophecies. The school is not to plan for the distant utopian future, but for the immediately emerging era. The emerging era is not altogether unknown; it is in reality, in part at least, the present seen in dynamic terms.

"In certain senses we know the immediate future better than we know the past, certainly better than the distant past. We are living in the emerging future and feel its impact. If we are careful to take into account the studies of trends . . . we can minimize the element of error. Moreover, the future will become the present soon enough and our prophecies will undergo the sharp test of reality. . . . Guided by knowledge and directed by ideas, we can, within limits, control the future. The school is one of the important levers for such control" [155].

In conclusion, although we cannot predict the future, we can prepare for it—and "he who is prepared is thrice-armed". As educators, we must help prepare our young people to meet and solve the problems of the new world of tomorrow—an entirely different sort of world whose complete shape and total pattern cannot as yet be clearly perceived—a world in which the youth of today will play the leading roles —a world in which our children may be forced to make the decisions which may well determine whether man shall continue his struggles to attain the heights, or whether he will plunge into the black abyss from which there is no returning.

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TESTING SCIENTIFIC TERMINOLOGY ON TELEVISION

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When university professors are faced with the problem of presenting scientific information over the medium of television it is difficult for them to know how much subject matter can be assimilated in a definite period of time. Considering the future possibilities for teaching science over television the present study was designed to make a quantitative measurement of the use of scientific terminology in television teaching of the science of horticulture.

A testing program was designed to measure the effectiveness of presenting three different quantities of scientific material to college freshmen who had no previous exposure to this subject matter. One television program was selected from the series as a sample and produced and recorded on a kinescope. It was then presented from a Bell and Howell movie projector, Model 185, to test audiences consisting of matched groups of first-term freshmen selected at random from the Communication Skills Division of the Basic College at Michigan State College. The groups were randomized and assigned to their respective cells in the statistical design.

The program was divided into three segments, a 15 minute segment which contained fifteen scientific terms, a 19 minute segment which contained twenty scientific terms, and a 24 minute segment, which contained twenty-five scientific terms. Three different groups of viewers were exposed to each of the three segments.

A recall test of the terms was made immediately after viewing the recording. Three minutes were allowed for the group receiving fifteen terms, four minutes for the group receiving twenty terms and five minutes for the group receiving twenty-five terms. Before testing each group, uniform instructions were provided.

A "comprehensive" test in which the students were asked to select the term which best fitted the explanation or definition was conducted immediately following the "recall" test. The group which received fifteen, twenty or twenty-five terms was provided with nine, thirteen and seventeen minutes respectively to complete the examination.

The testing program was conducted in a darkened room and each cell of students was motivated to cooperate by explaining the nature of the research problem and that their papers would remain incognito. The statistical design of the problem was a between-row, between-column pattern which facilitated the use of analysis of variance for the evaluation of the results. The test questions and word lists were randomized to alleviate sample errors. For the analysis of variance all cells were equalized to seventeen students using a randomized selection from the tables of randomized numbers.

Increasing the number of terms used on a program from fifteen terms in fifteen minutes to twenty terms in nineteen minutes to twenty-five terms in twenty-four minutes did not alter significantly the percentage of terms comprehended or recalled, when tests were made immediately following the exposure of a kinescopic recording of one program teaching horticultural science to a randomized group of students, (5 per cent level).

There was no significant change in the level of "recall". The percentage of "recall" between the "fifteen term" and "twenty-five term" groups was nearly equal. Between the "fifteen term" and the "twenty term" groups there was a decrease in the percent of recall but it was not significant at the 5 per cent level.

This meant that the group provided with the highest number of terms did learn more than either of the other groups. All the groups comprehended approximately the same percentage but this was in direct proportion to the number of terms to which they were exposed. Although there was evidence that the use of twenty-five terms was equally as effective as the use of fifteen or twenty terms, further research would be necessary to ascertain the number of terms which would be optimum for a thirty-minute telecast teaching horticulture.

SCIENCE EDUCATION RESEARCH STUDIES—1953

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THIS summary of research studies in science education is the fourth * annual listing which has grown out of a cooperative project involving the National Association for Research in Science Teaching and the Office of Education. Forty-six studies are reported in this summary for 1953.

Report forms and criteria for pertinent research studies were mailed to research leaders throughout the Nation in November 1953. As reports were received the summaries were prepared from the data given. No attempts were made to evaluate the quality of the research studies. The statements in the summaries of research studies were, except in a few instances, as reported by the author. The reports were sent to the Office of Education for the purpose of bringing research studies to the attention of those who seek such information.

Persons who know of related studies which were completed during 1953 but which are not included in this listing are urged to bring them to the attention of the Office of Education. These studies will then be included in the next annual listing.

The information given concerning each study includes, wherever possible, the fol-

* Copies of 1950 and 1951 listings may be obtained from the Department of Health, Education, and Welfare, Office of Education, Washington 25, D. C. The 1952 listing appears in *Science Education*, Vol. 38, No. 1, Febrruary 1954.

lowing items in the order given: author (surname first), title of study, "non-thesis" or degree if a thesis, year study was completed, institution where study was carried out, pages in the complete report, and source from which copy of the complete study may be obtained. This is followed by a statement of the problem or problems, methods used, sources of data, statistical treatment used, and major findings. Full information can be obtained best from the source given in the summary.

Since this is a service project, suggestions concerning ways to make the summaries of increased help will be appreciated.

This summary of research studies for 1953 was prepared through the cooperation of Dr. Kenneth E. Brown and Dr. Paul E. Blackwood of the U. S. Office of Education. Dr. Philip G. Johnson of Cornell University assisted with editorial work in preparation of the summaries.

ADEGBITE, JOSEPH ADEJUMOBI. Science Education and Developmental Tasks of Nigerian Youth. Ed.D., 1953, Columbia University. 200 P. Library, Teachers College, Columbia University, New York.

Problem or Problems.—To identify the developmental tasks of Nigerian youth as they seek to prepare themselves for adult life in a changing culture. The tasks identified were analyzed for implications for improvement of education of science teachers for Nigerian secondary schools.

Steps or Methods.—An opinionaire, supplemented by interviews, was employed to gather data concerning developmental tasks of adolescents. The opinionaire, consisting of 68 items, was administered to a sample of 120 boys in the upper four classes of the secondary school of the Baptist Academy, Lagos, (Nigeria), by the principal and the staff of the science department. The data obtained from the 116 completed returns were tallied, tabulated, and analyzed by categories for their implications for successful learning (or otherwise) of the developmental tasks indicated. Based upon this analysis, implications for science teaching and for teacher education were drawn, and recommendations made.

Sources of Data.—Opinionaire and interviews.

Statistical Treatment.—Analysis by categories.

Major findings.—The responses to the questions and statements comprising the opinionaire indicated a lack of adequate mastery of developmental tasks, and revealed the need to make the teaching of science functional in order to help adolescents learn these tasks. The only category of developmental tasks learned effectively was that of "acquiring information" on physical phenomena. The other nine categories of developmental tasks identified in the school setting as set up in the study were (1) science interests, (2) hobbies and handicrafts, (3) games and sports, (4) sex education and preparation for marriage, (5) health information, (6) vocation, (7) race and tribal relations, (8) intellectual maturity and value building, and (9) independence from adults.

The study also revealed that secondary schools of Nigeria would be required, at least for some years to come, to deal with developmental tasks of early adulthood.

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ALSTON, FRANK HOWARD. A Study of Science Interests of Pupils in Grades Nine Through Twelve at Hillside High School, Durham, North Carolina. M.A., 1953, North Carolina College. 52 P. Library, North Carolina College, Durham.

Problem or Problems.—(1) To determine the science subject areas and activities in which boys and girls express high and low interests. (2) To determine: (a) whether or not significant relationships existed among the interests in the three science areas sampled by the interest index; and (b) whether or not science interests were related to interests in reading and manipulative activities. (3) To determine whether or not the average marks made by students in science were related to their interests in science. (4) To discover the extent to which opportunities were provided in the school for pupils to explore their expressed interests in science.

Steps or Methods.—(1) The results of an interest index administered to 100 students in grades nine through twelve were analyzed for characteristic interests of boys and girls. (2) Central tendency statistics were used to determine the general characteristics of the data and product-moment correlations were run in an effort to uncover important relationships between the several categories of data on interests. (3) The group was divided into upper, middle, and lower thirds on the basis of the average mark in science obtained by pupils and the basis of expressed interests in science. Comparisons of these subgroups were made. (4) A check list of outstanding interests of students was compared with a list of science activities in the school.

Sources of Data.—Interviews, questionnaires, and P.E.A. Interest Index.

Statistical Treatment.—Mean, coefficient of correlation, and comparison of frequencies.

Major Findings.—(1) The strongest interests of boys were in physical science (75.7 per cent), biology (72.1 per cent), and manipulative activities (61.5 per cent). (2) The strongest interests of girls were in biology (67.3 per cent), and reading (59.9 per cent). (3) The Boys as a group

exhibited less variability in their dislikes for mathematics than the girls, although the girls as a group disliked a larger number of the mathematics activities than the boys. (4) Correlations between physical science and mathematics interests of boys were high and significant (.94), indicating a strong relationship. For girls, an obtained correlation of .77 suggested a moderate relationship between physical science and manipulative interests of girls. (5) Low and negligible correlations were obtained for mathematics and manipulative activities of girls (.18). (6) The girls exhibited a greater tendency than the boys toward verbalistic activities; but the boys, more than the girls, exhibited a tendency toward manipulative activities. (7) Obtained correlations between biology and physical science, .70 for girls and .54 for boys suggested a moderate relationship between these two groups of activities. (8) There was apparently little or no relationship between the interests of the students and their average achievement marks in science.

* * *

ARN, ELMER HOWARD ROBERT. The Prediction of Academic Success in Ten Selected Science Areas at the University of Washington. Ed.D., 1953, University of Washington. 217 P. Library, University of Washington, Seattle.

Problem or Problems.—(1) Whether the addition of three reading test variables to the eight predictor variables employed by Angell et al improves the prediction of first-year academic success in ten selected science areas at the University of Washington. (2) Whether the elaborate and time-consuming methods commonly employed in multivariable prediction studies can be shortened without loss in accuracy. (3) Which of three regression equations derived by the shorter method of calculation gives the most accurate prediction in the ten selected areas? (4) How accurately can first-year university grades in the ten selected areas be predicted with the eleven predictor variables employed?

Steps or Methods.—Composite Data Sheet, Control Sheet, I.B.M. Procedure, Correlation Work Sheet, Basic Intercorrelation Matrix, Application of the Multiple Regression Method, the Three Regression Equations, and verification and comparison of the Regression Equations.

Sources of Data.—Control groups and other statistical studies.

Statistical Treatment.—Analysis of variance and covariance.

Major Findings.—(1) The Multiple Regression Method promises to make multi-variable prediction studies practical without a loss in accuracy, and addition of more predictor variables is no longer prohibitive. (2) Use of a basic matrix in study similar to one discussed is justified. (3) No single item of information on freshmen students affords an adequate index of ability to do efficient college work. (4) The application of the differential prediction of academic success in different university subject areas promises a better academic adjustment of students and reduction of university failures. (5) The addition of 3 reading test variables from reading section of the Cooperative English Test to the 8 predictors employed in the 2-year study of the 1947 group did not appear to improve the 1950 prediction of first-year academic success in the ten selected science areas by an appreciable amount. (6) The true contribution of reading cannot be evaluated in terms of the difference between R_c (1...11) and R_c (1...8), for reading is incorporated in the other 8 variables employed. (7) The maximum multiple correlation coefficient is statistically possible. In terms of the reliability of the variables involved, it has been reached in a number of the ten science areas selected. If all students always worked up to capacity; if there were some way of knowing how much time, energy, and intelligent application each student devoted to his studies, and if instructors used more objective methods of appraising student achievement, still further reduction in the errors of prediction appears possible. (8) In the determination of the regression equations for the selected areas the accuracy of the predictions was not affected when the independent variable sigmas and means of the "all university group," rather than those of the criterion group, were used. (9) In all the selected science areas where more than 100 cases were available the accuracy of the predictions, in terms of the differences between the actually achieved and predicted grades, was well within the limits of the calculated standard errors of estimate. (10) The 1950 regression equation, derived to predict average university grades in chemistry, engineering, geology, home economics, physics, and zoology should, within the limits claimed, prove applicable to future freshman groups at the University of Washington. Until the 1950 regression equations in biology, botany, forestry, and pharmacy are revised by the addition of more cases from subsequent freshman groups, future predictions within the 1950 standard errors of prediction may be expected. (11) As the validity of the variables involved in the 1950 study may be expected to undergo changes, a periodic evaluation of future predictions made with the 1950 regression equations will be essential.

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BALCZIAK, LOUIS WILLIAM. The Role of the Laboratory and Demonstration in College Physical Science in Achieving the Objectives of General Education. PhD., 1953, University of Minnesota. 176 P. Library, University of Minnesota, Minneapolis.

Problem or Problems.—To determine the relative effectiveness of the demonstration, the combined demonstration and the individual, and the individual methods of conducting laboratory work in a course in physical science designed for general education purposes.

Steps or Methods.—The method was that of a controlled modern experiment making use of a 2 x 3 randomized block design and the techniques

of the analysis of variance and covariance. The experiment continued throughout the academic year and involved 144 students arranged at random into 6 sections. Three outcomes were measured: science information, scientific attitudes, and laboratory performance.

Sources of Data.—Experimental groups and control groups.

Statistical Treatment.—Analysis of variance and covariance.

Major Findings.—Significant gains were made under each of the three methods in science information and in laboratory performance. Only under the individual method was there a significant gain in scientific attitude. There was a significant increase in variability on the laboratory performance test in one section of each of the three methods. There was no significant difference in means among the several methods in the three outcomes measured.

* * *

BARNETT, SUE MALONE. A Study of Our Marine Environment as a Florida Resource to be Used in the Elementary Science Program. M.S., 1953, Florida State University. 95 P. (copy of study not available).

Problem or Problems.—To determine the possibilities of using the marine environment in enriching the elementary science program.

Steps or Methods.—(1) A course in marine biology. (2) Many field trips to coast. (3) Stocking and maintaining aquaria. (4) Experience with elementary children.

Sources of Data.—Field work, reference books, and periodicals.

Statistical Treatment.—None.

Major Findings.—(1) Extensive knowledge in biology and ecology is not necessary for profitable utilization of marine materials in the elementary science program. (2) A study of marine life will enrich the science program in the elementary school.

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CALDWELL, LOREN THOMAS. A Determination of the Earth Science Principles Desirable for Inclusion in the Science Program of General Education in the Secondary School. Ed.D., 1953, Indiana University. 199 P. Library, Indiana University, Bloomington.

Problem or Problems.—(1) To derive from an analysis of published materials in the earth sciences those principles which may be used in the science program of general education in the secondary school. (2) To determine the relative importance of earth science principles which are desirable for inclusion in the science program of general education in the secondary school.

Steps or Methods.—This investigation consisted of three phases. (1) The compilation of source materials in the earth sciences. (2) An analysis of selected earth science sources for statements of tentative earth science principles. (3) The determination of the relative importance of earth science principles which are desirable for inclusion in the science program of general education in the secondary school. The relative importance of the earth science principles was determined by five science educators who have furnished outstanding leadership in the teaching of science.

Sources of Data.—Reference books, periodicals, and textbooks.

Statistical Treatment.—Comparison of frequencies.

Major Findings.—In all, 332 principles of the earth sciences were derived from an analysis of all sources of materials in this investigation. On the basis of the independent ratings by a jury of evaluators, 296 of these 332 principles were judged to be desirable for inclusion in the science program of general education in the secondary school. Of these 296 desirable earth science principles, 191 earth science principles were judged as highly desirable and 105 were judged as desirable. There were 123 which related primarily to the area of geology, 60 to physical geography (including weather and climate), 60 to the area of astronomy, and 53 to the area of the scientific aspects of conservation.

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CONRAD, HALLIE M. Science Practices Used by Selected Elementary Teachers. M.A., 1953, Ball State Teachers College. 51 P. Library, Ball State Teachers College, Muncie, Indiana.

Problem or Problems.—Who is responsible for teaching elementary science, where and when is it taught, what equipment is available, and what is further needed to improve a science program in the elementary grades?

Steps or Methods.—Data for the study were obtained from seven science supervisors and thirty-five elementary science teachers located in Cleveland, Ohio; Louisville, Kentucky; Fort Wayne, Indiana; Richmond, Indiana; and New Castle, Indiana. Elementary teachers were interviewed and observed in their classrooms, and each submitted information relative to their science practices on a questionnaire constructed by the investigator. This information was tabulated showing practices of selected elementary science teachers in rank order of importance.

Sources of Data.—Interviews and observations of teachers.

Statistical Treatment.—Mean, comparison of frequencies, and rank order.

Major Findings.—(1) Homeroom teachers were responsible for nearly all of the science taught in kindergarten through the sixth grade. (2) A definite science period each week was characteristic of more than one-half of the teachers interviewed. (3) Movable tables and chairs in the classrooms made group work much easier. (4) More than one half of the science equipment was stored in storage rooms. (5) Science books and magazines were used extensively in all schools observed. (6) Five science units ranked in order of importance to 35 elementary science teachers were: plants, weather, health and safety, animals,

and air. (7) The farm, a walk, the dairy, parks, and the airport were considered the most important places for field trips. (8) More time to plan, more time to teach science, more trained teachers in elementary science, and more integration of science work were outstanding suggestions for needed science improvement. There is definite science work being done in selected schools where the curriculum had been judged successfully for many years.

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COOK, ROBERT E. A Suggested Science Room Design for Nebraska Schools. M.A., 1953, University of Nebraska. 109 P. Library, University of Nebraska, Lincoln.

Problem or Problems.—To develop a design for an adequate science classroom in which general science, biology, physics, chemistry, or other high school science offering may be satisfactorily taught.

Steps or Methods.—The author used selected school visitation, conference, correspondence, and other techniques to accumulate basic data on science room design.

Sources of Data.—Interviews, reference books, periodicals, visitation to see facilities, and worksheets.

Statistical Treatment.—Mean and median.

Major Findings.—A room design for general science, biology, physics and chemistry classes with adjoining storerooms was proposed.

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DELOACH, WILL S. General Chemistry Textbook Prices, 1925–51. Non-thesis, 1953, Arkansas State Teachers College. 2 P. Author, Arkansas State Teachers College, Conway.

Problem or Problems.—Investigation of the "real cost" of college general chemistry textbooks published 1925–51. Prices of the books were adjusted to allow for variation in purchasing price of the dollar.

Steps or Methods.—A survey of prices of textbooks from the literature from 1925–51.

Sources of Data.—Reference books and periodicals.

Statistical Treatment.—None.

Major Findings.—"Real cost" of college general chemistry textbooks rose during depression years, then declined, and in 1951 was at its lowest (except for one year).

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DIETRICH, MARY ALICE. A Suggested Course of Study for Introductory College Biology, with an Emphasis on the Study of Living Material. Ph.D., 1953, Cornell University. 173 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—To provide specific suggestions for a course in introductory college biology, which is concerned with the study of living materials. The apparent need for such suggestions came to the author's attention after several years of experience of teaching in several institutions.

Steps or Methods.—Consultation of literature including biology textbooks and laboratory manuals, current periodical literature, and theses.

Sources of Data.—Reference books, periodicals, and textbooks.

Statistical Treatment.—None.

Major Findings.—The course outlined in this thesis could be adapted to local situations and would give an instructor help in including living materials in courses in biology and in overcoming the obstacles of limited time and space.

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DUBINS, MORTIMER IRA. Current Practices in Elementary School Science with Reference to Courses of Study Published from 1940 to 1952, and the Extent of Activities Undertaken for the Improvement of Instruction. Ed.D., 1953, Boston University. 543 P. Library, Boston University, Boston, Massachusetts.

Problem or Problems.—(1) To determine the content of several courses of study in elementary school science published since 1940. (2) To determine what was being done for the improvement of elementary science instruction. (3) To make available a source of information concerning the present practices in instruction in science in the elementary schools of the United States.

Steps or Methods.—(1) List of courses of study in elementary science published from 1940–1952 was compiled. (2) Courses of study were obtained. (3) Courses of study were subjected to a topical analysis involving five major areas of the environment divided into 34 sub-areas which in turn were divided into topics. (4) Science principles suitable for instruction in the elementary school were sought and their frequency of occurrence recorded. (5) Objectives were analyzed and activities for pupils and materials for instruction were tabulated. (6) Transmittal of inquiry forms to a stratified random sample involving State Departments of Education, science educators and members of a direct request sample. (7) Analysis of returned inquiry forms.

Sources of Data.—Courses of study and questionnaires.

Statistical Treatment.—Coefficient of correlation.

Major Findings.—(1) A topical subject matter content guide was developed as an encyclopedia of topics logically presented, and at the same time a report of present practice. (2) Less than 4 per cent of the 476 major topics reoccurred in over half of the 163 grade-courses of study. Slightly less than one sixth of the major topics reoccurred in from 25 to 49 per cent of the grade-courses of study. (3) The more than 450 topics present in the courses of study in elementary science reveal confusion in what subject matter to teach. (4) Evidence of grade placement of several major topics was discovered. (5) Doubt and confusion exists as to what principles should be taught in the elementary school. (6) Larger

cities are more likely to publish a course of study in elementary science, to employ consultants in making a course of study and to hold science conferences and workshops for the elementary school teacher. (7) Most of the states have colleges which are presenting workshops in science for the elementary teacher. (8) Fewer than 10 per cent of the states have agencies which publish pamphlets in science for the elementary school teacher.

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ELLIOTT, JAMES MCFARLAND. An Evaluation of Certain Courses in Relation to Understanding of Principles in a Biological Science Course. Ed.D., 1953, Michigan State College. 443 P. Library, Michigan State College, East Lansing.

Problem or Problems.—(1) To obtain from the staff of the Department of Biological Science an evaluation of the content of the "Biological Science Lecture Syllabus" relative to an understanding of the principles presented in the course and (2) to derive from these data certain inferences and generalizations having implications for (a) the objectives of biological science, (b) the "minimum essentials" concept as it relates to biological science, (c) the revision of the "Biological Science Lecture Syllabus" and the "Study Guide for Biological Science," (d) the examination program in biological science, and (e) the preparation of laboratory studies for biological science.

Steps or Methods.—(1) Construction of the rating instrument. (2) Administration of the instrument. (3) Analysis of evaluations obtained by means of the instrument. (4) Determination of reliability of the rating instrument. (5) Formulation of conclusions and educational implications.

Sources of Data.—Expert judgments and questionnaires.

Statistical Treatment.—Coefficient of correlation.

Major Findings.—It was possible to conclude that, in the opinion of the teaching staff, the "Biological Science Lecture Syllabus" contains facts which contribute in varying degree toward an understanding of principles presented in the course. Furthermore, the staff of the Department of Biological Science, acting collectively, was able to identify the factual elements of the course in the order of the importance of contribution toward an understanding of principles.

This study indicated that the lecture syllabus does not treat adequately, by comparison, all of the principles presented in the study guide. This study not only indicates areas where revision is particularly needed, but that it also provides information concerning the general nature of the change.

The content of the lecture syllabus does not adequately contribute toward the attainment of the course objective "to acquire knowledge of some of the basic laws (principles) of biology" if it is assumed that this contribution must take the form of an adequate contribution by the syllabus content toward and understanding of the principles presented in the study guide.

Data support the contention that by means of a detailed analysis of a course of study it is possible to marshall the factual elements of course content into orderly support of the major concepts and principles upon which the course is based.

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FISHER, CARL M. A Plan to Improve Science Education in the Mainland High School, Daytona Beach, Florida. M.S., 1953, Florida State University. 43 P. Library, Florida State University, Tallahassee.

No review provided.

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FRANKS, CLEVELAND JAMES. The Organization, Installation, Implementation, and Administration of a Course in Physical Science Designed for General Education at the Morgan State College. Ed.D., 1953, Columbia University. 212 P. Library, Teachers College, Columbia University, New York, New York.

Problem or Problems.—(1) What are the types of situations, problems and interests most likely to challenge the individual in the course of his living in a democratic society, and how are these related to our institutions and ways of living? (2) What kinds of abilities and traits do we seek to develop in our students as we help them to prepare for effective participation in our society?

Steps or Methods.—A two-year experimental science program was developed from student's real problems and interests. This course was offered to four classes for two years and compared with the traditional physical science survey course which was offered simultaneously to four classes. Both courses were evaluated and conclusions were based on the findings.

Sources of Data.—Experimental groups.

Statistical Treatment.—None.

Major Findings.—For most non-science majors, a different kind of course is needed from the specialized courses provided in the various science departments. The "block-and-gap" approach is better than the superficial survey or diluted orthodox science course. Student suggestions and criticisms can be of value in locating weaknesses in a program designed for general education science. The general education science program should be flexible enough to allow the teacher to capitalize on the special interests and capacities of the pupils.

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GLIDDEN, HARLEY F. The Identification and Evaluation of Principles of Soil and Water Conservation for Inclusion in the Secondary School Curriculum. Ph.D., 1953, University of Nebraska. 241 P. Library, University of Nebraska, Lincoln.

Problem or Problems.—(1) What principles within the area of soil and water conservation

should be developed at the secondary school level? (2) How well are these principles being learned from active participation in American life, as from school, club work, reading, listening to radio, etc.? (3) Do modifications of the secondary school curriculum in the areas of soil and water conservation seem desirable?

Steps or Methods.—(1) Acquiring from specialists and recognized practicing conservationists in the area of soil and water conservation lists of available bulletins, monographs, pamphlets, and other printed material which these persons designated as containing subject matter and materials valuable for inclusion in the secondary school curriculum. (2) Analysis of these materials to determine the principles contained or developed in the recommended material. (3) Submission of the resulting list of principles to additional specialists to check for accuracy of subject matter, for clarity of statement, for omissions, duplications, and pertinent additions. (4) Submission of the refined list of principles to two different groups of specialists in education, science educators and secondary school curriculum for evaluation of adaptability and importance for the secondary school curriculum. (5) Statistical analysis of the evaluations of the principles. (6) Elimination of undesirable principles on the basis of statistical data. (7) Preparation of a test intended to measure knowledge and understanding of the more important and adaptable principles. (8) Establishment of the validity and reliability and internal consistency of this test. (9) Revision of the test to secure a valid and reliable test instrument. (10) Administration of the revised test to first quarter freshmen to determine the internal consistency and reliability of the final form of the test. (11) Administration of the test to seniors in selected secondary schools. (12) Analysis of test results to determine whether or not the principles considered to be important are now adequately taught in the existing secondary school curriculum or are being vicariously learned through participation in American life.

Sources of Data.—Experimental groups, control groups, expert judgments, questionnaires, pamphlets, and bulletins.

Statistical Treatment.—Mean, standard deviation, coefficient of correlation, critical ratio, Fisher's "t," comparison of frequencies, analysis of variance and covariance, point biserial coefficient of correlation, and a special rating technique.

Major Findings.—This study has contributed (1) A list of twenty-nine bulletins, monographs, pamphlets, and other printed materials which are of value as a part of the knowledge of all citizens. (2) A list of sixty-six basic principles of soil and water conservation which has been approved by both professional conservationists and professional educators. (3) A test intended to measure important facts and understandings in the area of soil and water conservation. (4) Evidence that professional science educators as a group do not differ significantly from other professional educators in their judgment of the importance and appropriateness of principles of soil and water conservation as guides to curriculum construction in secondary schools. (5) No evidence that the size of population center or the geographic region in which a school is located affects the knowledge of soil and water conservation possessed by pupils in that school. (6) Differences in knowledge of soil and water conservation, too large to be attributed to chance, exist between groups of high school pupils enrolled in different schools. (7) The per cent of mastery of the principles of soil and water conservation as revealed by the test used in this investigation ranged from 31.06 per cent to 56.47 per cent with an average for the thirty-three schools of 44.18 per cent.

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HARTSHORNE, JAMES MOTT. An Elementary Course in the Fundamentals of Radio Communications Designed for the Secondary School Level. M.S., 1953, Cornell University. 174 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—To developed a course in the fundamentals of radio which would enrich the science program. The course would be designed for high school pupils who had completed a course in physics.

Steps or Methods.—Review of recent secondary school science texts from the standpoint of basic electricity. Development of a course of study including experiments.

Sources of Data.—Reference books, periodicals, and textbooks.

Statistical Treatment.—None.

Major Findings.—A course was suggested which could be completed in 18 weeks if the class met for 1½ hours twice a week.

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JACKSON, FERN I. Science Interests of Elementary Children and Activities Devised to Satisfy Their Interests. M.A., 1953, Ball State Teachers College. 81 P. Library, Ball State Teachers College, Muncie, Indiana.

Problem or Problems.—What are children's interests and needs in science and how can one develop an instructional program that would satisfy children's interests?

Steps or Methods.—Fifth-grade children, having had little or no systematic science instruction in previous grades, participated in the study. These children were observed on the playground, in the classroom, and in many out-of-school situations in order to identify their interests in science. Objects which children brought to school were sources of information as to their concerns. Suggestions and comments relating to science were recorded and analyzed by the investigator. After the children's interests were surveyed, an attempt was made to plan science experiences which would help children solve their problems. The children were given an active part in suggesting problems and in planning ways to solve them.

Sources of Data.—Interviews and observations.

Statistical Treatment.—None.

Major Findings.—Of greatest interest to fifth-grade children were "Rocks." Other units were "Turtles," "Magnetism," "Electricity," "Sound and Hearing," "Air," and the "Earth's Surface."

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JENSEN, JENS TRYGUE. Nuclear Energy—Basic Principles, Applications and Implications. Ed.D., 1953, Columbia University. 145 P. Library, Teachers College, Columbia University, New York, New York.

Problem or Problems.—To develop a resource unit in atomic energy for teachers of physical science.

Steps or Methods.—Through a study of the literature in the field, material was compiled on (a) principles of nuclear energy, (b) possible uses of atomic energy, and (c) implications of these uses.

Sources of Data.—Reference books, periodicals, textbooks, and personal experience.

Statistical Treatment.—None.

Major Findings.—Nuclear energy, although not at present economically feasible, may become an important source of power. The use of tracers is becoming increasingly important. The resource unit in atomic energy should enrich the course in physical science.

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JONES, DAVID GORDON. The Use of Rare or Unusual Materials to Incite Interest and Individual Work in High School Biology. Ed.M., 1953, Cornell University. 65 P. Library, Cornell University, Ithaca, N. Y.

Problem or Problems.—To collect unusual material for use in the motivation of the study of biology.

Steps or Methods.—Survey of the literature.

Sources of Data.—Reference books, periodicals, and textbooks.

Statistical Treatment.—None.

Major Findings.—The material collected was interesting to pupils: It seemed to create a further interest in biology. The idea of adventure and individual discovery was stressed in the material.

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KAIKOW, JULIUS. The Legal and Administrative Status of Conservation Education in the United States. Ph.D., 1953, Columbia University. Library, Teachers College, Columbia University, New York, New York.

Problem or Probelms.—To determine the extent to which conservation education has been given official as well as unofficial recognition and to determine the type of material taught as conservation in this country.

Steps or Methods.—(1) Questionnaires. (2) Interviews. (3) Study of courses of study. (4) Periodical reports. (5) Other printed sources. (6) Personal Observations. (7) Publications of interested organizations.

Sources of Data.—Questionnaires, courses of study, interviews, reference books, periodicals, expert judgments, and personal observation.

Statistical Treatment.—None.

Major Findings.—Eleven States have mandatory legislation on conservation education. Not all follow the letter of the law. Twenty-five States plus the District of Columbia have an official administrative policy on conservation education. Of the rest, three are in the process of transition to a definite policy status. In a few States the conservation authorities carry the burden of conservation education. In only a relatively few States is total conservation taught. Emphasis is only on a few resources, usually organic or renewable in character. Exhaustible resources are largely ignored.

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LORBEER, GEORGE COLE. A Determination of Certain Changes in Parental Understandings, Attitudes, and Interests as Compared with Those of Their High School Children Following a Teaching Unit in Atomic Energy. Ed.D., 1953, University of Illinois. 138 P. Library, University of Illinois, Urbana.

Problem or Problems.—To test the hypothesis that certain parental knowledges, opinions, and interests would result from an instructional unit taught to high school children. The study sought specifically to determine if any measurable changes in understandings, attitudes, and interests in the parents would accompany comparable changes in their high school children.

Steps or Methods.—The study was an experimental-control type. One high school served as an experimental school; the other as a control. 273 students were used in both schools. (1) All the parents of both groups were pre-tested on an atomic energy questionnaire. (2) All the students involved in the study were given the same test. (3) A two-week unit on atomic energy was taught in the experimental school. (4) All the students were given a final test covering the same item. (5) The parents of both groups were given a post test, also using the same items.

Sources of Data.—Reference books, periodicals, experimental groups, control groups, interviews, and questionnaires.

Statistical Treatment.—Chi square, Fisher's "t," coefficient of correlation, mean, and standard deviation.

Major Findings.—(1) Significant differences were found that would seem to indicate that substantial parent education had been achieved through the indirect method provided for in this study. (2) The parents of the experimental group acquired a measure of new facts and understandings, changed a few of their opinions, and altered some of their appraisals in the area of this investigation. Their gains in these items were significantly greater than those of the control

group of parents. (3) Twenty-one factors were isolated to see if they showed any significant differences. None of these did. Such items as intelligence rating, scholastic ability, and religious affiliation were a few of the items tested. (4) Data from the files (subjective judgment) showed that the highest quartile of parents in gains made were much "closer" to their children than were the remaining three-quarters.

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LUCOW, WILLIAM HARRISON. The Use of Analysis of Variance in Estimating the Components of Variation in an Experimental Study of Learning: Textbook-Centered vs. Laboratory-Centered Approach in the Teaching of Introductory High School Chemistry. Ph.D., 1953, University of Minnesota. 232 P. Library, University of Minnesota, Minneapolis.

Problem or Problems.—To determine the effect of two different methods of instruction upon individual differences.

Steps or Methods.—Two independent parallel experiments were run, the one involving an accelerated course for college preparatory students, the other, non-accelerated and students not preparing to enter college. Analysis of variance was used to interpret the data.

Sources of Data.—Experimental groups and control groups.

Statistical Treatment.—Analysis of variance and covariance.

Major Findings.—With accelerated pupils, the textbook-centered approach and the laboratory-centered approach both produced statistically significant increase in variation. However, the laboratory-centered approach produced greater variation. With non-accelerated pupils, the laboratory-centered approach was superior to the textbook-centered approach in producing a statistically significant increase in variation. Both methods produced significant changes in mean achievements. The techniques of component analysis were demonstrated and confidence intervals were set up for various components of variation.

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MARSH, MARJORY B. Content Analysis of Selected Elementary Science Courses of Study Compared with Content Recommended by Some Selected Expert Teachers of Elementary Science. M.A., 1953, Ball State Teachers College. 40 P. Library, Ball State Teachers College, Muncie, Indiana.

Problem or Problems.—How does the content of selected courses of study compare with the contents which experts prefer in an elementary science program?

Steps or Methods.—The content of nineteen courses of study, placed in use since 1945, was compared with the contents desired by 35 elementary science teachers considered expert in science. A checklist prepared by the investigator served as an instrument for obtaining information relative to the content in science desired by elementary teachers.

Sources of Data.—Courses of study and expert judgments.

Statistical Treatment.—Comparison of frequencies.

Major Findings.—Teachers considered as experts in elementary science preferred the following: (1) *Curriculum Guide in Elementary Science to Course of Study* as a title; (2) a vertical column organization on paper 8½" by 11" and bound at the left; (3) a general section of the course of study containing a list of scientific attitudes, a list of possible sources of materials, a list of objectives, well developed resource units, suggestions for the use of free, and inexpensive materials, and a general bibliography; (4) some kind of units: learning or resource; (5) a list of visual aids, and (6) units on electricity, living things, weather and climate, simple machines, animals, birds, magnetism, insects, sound, and light.

The teachers regarded the ten most essential units of the elementary science program to include: electricity, living things, weather and climate, astronomy, simple machines, plants, animals, magnetism, conservation, and health.

Courses of study in elementary science placed in use since 1945 agree rather well especially in subject matter, with the preference of teachers considered expert in the field of science. The greatest disagreement is in the general contents of the courses of study and the format.

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MCGAY, CULBERT, JR. Developing an Orientation for the General Education Teacher with a Special Competence in Science. Ed.D., 1953, Columbia University. 139 P. Author, 352 Meadowbrook Avenue, Eatontown, New Jersey.

Problem or Problems.—(1) To develop a useful pattern of educational theory for the general education teacher who possesses a special competence in the sciences. (2) To discover new types of educational experiences which are better suited to present day needs than the experiences commonly found in college science classes.

Steps or Methods.—(1) Study of the factors which have brought about the demand for "General Education," and discussion of each, grouped under the general headings (a) sociological factors, (b) philosophical factors, and (c) psychological factors. (2) Review of the literature describing many of the new science-related courses which have been developed.

Sources of Data.—Courses of study, reference books, periodicals, expert judgments, and textbooks.

Statistical Treatment.—None.

Major Findings.—A study of the developmental tasks of young people, the present needs of society, and the facts of educational psychology, suggests the need for new kinds of educational experiences in college science classes. A few of these new kinds of experiences can be discovered

in some of the science classes designed for general education.

Twelve general education science courses are analyzed to discover the kinds of experience which students have in these classes. Those educational experiences which seem best suited to helping young people in our society with their developmental tasks are suggested as appropriate for use by the general education teacher.

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McWHIRTER, NOLAN. The Status of General Biology in the General Education Program of Colleges and Universities in Arizona, Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. M.A., 1953, Colorado State College of Education. 95 P. Library, Colorado State College of Education, Greeley.

Problem or Problems.—To establish the status in course content and methods in general biology in the general education programs of colleges and universities in seven southwestern states.

Steps or Methods.—The data for this study were obtained by use of a questionnaire. A letter was sent to the director of admissions of each of the 119 institutions found in the seven southwestern states asking the participation of that institution and explaining briefly the purpose of the study. A postcard was enclosed for convenience in replying. Those institutions agreeing to take part in the study were sent a two-page short-answer type of questionnaire containing 23 questions.

A total of 70 institutions or 58.82 per cent of the four-year institutions in the seven states agreed to take part in the study. A number declined because general biology was not included in the curriculum of their schools.

All four-year institutions were included. No effort was made to segregate on basis of enrollment, teachers college or liberal arts, white or colored in order to give an overall picture of the status of general biology in the Southwest.

Sources of Data.—Questionnaire.

Statistical Treatment.—None reported.

Major Findings.—General biology is a part of the general education program in 84.69 per cent of the institutions represented in this study. A number of institutions not represented in the study are planning to add general education programs and general biology as a part of that program in the near future.

Sixty-two of the sixty-four institutions list general biology as either a definite requirement or a strongly recommended course for all non-science majors. In a few cases botany or zoology may be substituted for biology.

General biology is offered as a freshman course in most institutions with some placing it during the first two years.

Laboratory is a part of the general biology course in 80.64 per cent of the institutions responding to the questionnaire.

The general biology course is a one-semester course for four credit hours (semester hours) in the majority of the institutions, and 82.85 per cent of the instructors in the institutions represented by this study were men,—41.42 per cent hold the rank of professor or its equivalent. Assistant professors and instructors each make up 20 per cent of the total and associate professors 17.14 per cent.

Eighteen different texts were used in the 53 institutions listing their texts. No one text could be listed as being the one used by a majority of the institutions. Twenty-eight different scientific publications were listed as valuable for additional student reading.

Both science and non-science instructors felt general biology fitted the student need in the general education program better than did a more specialized science. The method of teaching would vary with the instructor, the students and the institutional needs.

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MILLER, CLARENCE ECKMAN. Utilization of Photography to Enrich and Motivate the Biology Curriculum of Lewis and Clark High School. M.Ed., 1953. University of Washington, Seattle.

No review provided.

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NELSON, VERNON RONALD. The Design and Construction of the Audio-Viewer. Ed.D., 1953, University of Colorado. (23 P. Library, University of Colorado, Boulder.

Problem or Problems.—To design and construct an electronic audio-visual device which would give to the music student direct, purposeful experience in the development and perfection of pitch, volume, and quality control.

Steps or Methods.—(1) Design of instrument. (2) Construction of instrument. (3) Testing of instrument.

Sources of Data.—Reference books, periodicals, and textbooks.

Statistical Treatment.—None.

Major Findings.—In addition to its uses in the study of the pitch, volume, and quality of musical sounds, the audio-viewer will show the effects of posture, relaxation, controlled breathing, vibrato, and embouchure. It may be used as a tuning device, permitting mass tuning, or to demonstrate such musical and physical phenomena as beats harmonic analysis, tone synthesis, and resonance.

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NEWSOM, CARL RAY. General Education Science in Methodist-Related Junior and Senior Colleges. Ph.D., 1953, George Peabody College, Library, George Peabody College for Teachers, Nashville, Tennessee.

Problem or Problems.—To determine the present status, content and objectives, procedures of instruction, and the amount of religion and philosophy in general education science courses in Methodist-related junior and senior colleges.

Steps or Methods.—(1) Search of literature. (2) Study of college catalogs. (3) Questionnaires.

(4) Study of textbooks. (5) Personal correspondence. (6) School visitation.

Sources of Data.—Textbooks, courses of study, interviews, and questionnaires.

Statistical Treatment.—Coefficient of correlation and comparison of frequencies.

Major Findings.—Most schools offer general education courses. Of the courses recommended for non-science majors, 47 per cent were one year in length and 36 per cent were one semester in length. Classes were usually very large (45 students). Courses consisted primarily of physics. Thirty-eight per cent of instructors had Ph.D. Few were employed to teach only general education school courses.

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OXENDINE, HERBERT GRANTHAN, AND READ, JOHN GAMMON. The Grade Placement of the Physical Science Principle "Sound is Produced by Vibrating Material" in Relation to Mental Ages. Ed.D., 1953, Boston University. 124 P. Library, Boston University, Boston, Massachusetts.

Problem or Problems.—The investigator, using a classroom demonstration technique, took the principle, "Sound is produced by vibrating material," and endeavored to discover at which grade level in relation to mental age the teacher may expect to get maximum learning.

Steps or Methods.—(1) Secured administrative permission to conduct study in schools selected. (2) Briefed the teachers on how they might assist in the testing procedure. (3) Administered a pre-test to the total population on the principle of sound. (4) The fourth and sixth grades each were divided equally into two groups randomly. (5) One-half of the fourth grade was placed with one-half of the sixth grade forming a group called the experimental group. (6) The remaining fourth and sixth grade pupils were placed in a group called the control group. (7) The experimental group witnessed the lecture-demonstration on the principle, while the control group engaged in a period of silent reading. (8) Both groups took a post-test. (9) The total population was given the Otis Quick Scoring Mental Ability Test Form Beta to establish their mental age. (10) Within a period of three to four weeks a retest, identical to the post-test was given to test retention in the experimental group, and to test any increase or decrease in knowledge of the principle in the control group.

Sources of Data.—Experimental groups and control groups.

Statistical Treatment.—Mean, standard deviation, coefficient of correlation, Fisher's "t," analysis of variance and covariance, and item analysis to establish item difficulty for total test items.

Major Findings.—Statistical analysis of the data indicates that the mental age level of 11–12 years is that point where the pupils attain mastery of the test. Concerning grade placement of the principle, the data indicate that the pupils of the fourth grade are not ready for this instruction. It is possible that in an urban fringe area the fifth grade pupils may be ready for this principle. At the sixth grade level, 57 per cent of the pupils, after having seen the lecture-demonstration on the principle of sound, mastered the test. This indicates that these pupils are ready for the instruction.

During the time lapse between the post-test and the re-test, it was found that there was a significant increase in knowledge concerning the principle of sound. This is probably due to the pooling of experiences among the pupils, practice effect to the test or information concerning the principle during the time-lapse. Therefore, the investigator feels that the retention of knowledge is good when the lecture-demonstration method is used in teaching science by principles.

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PEDLOW, MARGARET ELEANOR. Techniques and Suggestions for Kodachrome Slide Sequences That Can Be Prepared by the High-School Biology Teacher. Ed.M., 1953, Cornell University. 49 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—To prepare suggestions on the use of Kodachrome slides in the study of biology.

Steps or Methods.—The writer included in this paper the various techniques used in the field and the techniques that have been suggested by other nature and scientific photographers.

Sources of Data.—References and interviews.

Statistical Treatment.—None.

Major Findings.—Sequences of Kodachrome slides were presented that were helpful in the teaching of biology. It was concluded that the material, if used properly in connection with laboratory work, field trips, or class excursions, can be very useful in supplementing the biology instruction.

* * *

PERHACH, ANDREW GEORGE. Materials and Equipment for Elementary School Science. M.S., 1953, Illinois State Normal University. 55 P. Library, Illinois State Normal University, Normal.

Problem or Problems.—To develop a list of science equipment and materials useful to school administrators, supervisors, and teachers in the development and maintenance of a basic continuous elementary science program.

Steps or Methods.—(1) Recent literature related to problem was reviewed. (2) A specific list of science equipment and material was prepared based on each of eight widely used science textbook series and teacher's manuals published from 1940 to 1952. (3) A composite preferred list of items based on occurrence in four or more series, and also on two levels, namely grades 1 to 6 and grades 7 and 8 was prepared. (4) The findings of this study were compared to similar studies and recommendations for their use were given.

Sources of Data.—Reference books, periodicals, textbooks, and courses of study.

Statistical Treatment.—None.

Major Findings.—The specific list of science equipment and materials for each of 8 science series as well as the composite list of science equipment and materials for all 8 was developed. It can be used as a check list in any school system attempting to work up an adequate supply of equipment and materials.

* * *

PREWITT, CHARLES WALKER. Relationships of Science and Democracy to Education. Ed.D., 1953, Columbia University. Library, Teachers College, Columbia University, New York, New York.

Problem or Problems.—What type of educational program will aid people in becoming more democratic-scientific citizens?

Steps or Methods.—From reference books and periodicals, from consultations with faculty members, and from personal experience, there were proposed five criteria which described for the study the institutions of science and democracy. These criteria were compared combined, and used as a basis for an educational philosophy and methodology in science education.

Sources of Data.—Reference books and periodicals.

Statistical Treatment.—None.

Major Findings.—It was concluded that the criteria, which for the study described the institutions of science and democracy, were fundamentally complementary and supplementary. Further, these criteria could be and were combined and used as a basis for an educational philosophy and methodology of science education.

* * *

PYLE, JEAN GILMORE. Materials on Fish and Fisheries Management Published by the United States Government and the States—With Annotations and Discussions of Suitability for Use by Persons Without Technical Training and for Use in Children's Camping Programs M.A., 1953, Cornell University. 104 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—(1) To list available free or low cost materials on fish, fisheries, farm ponds, and fish management. (2) To discuss the material in terms of its usability by the layman and in a camp program.

Steps or Methods.—A survey of Conservation and Extension Departments was made by a questionnaire on a double-fold postcard. Reference materials were studied. Analyses were made to secure suitable materials.

Sources of Data.—Reference books, periodicals, and questionnaires.

Statistical Treatment.—None.

Major Findings.—The conservation of fish is a job in which everyone can take part. It is possible to read about fish, study about them, take a guided field trip and do many other things to understand and to help in management and conservation practices. Many persons including children can help make our streams, lakes, ponds better for fish and for the recreation of fishing. There are a very large number of publications that can be of assistance in programs of this type.

* * *

RAY, SISTER M. AMADEUS. Nationwide Status of the Integrated Course in Physical Science. Ed.M., 1953, Boston University. 34 P. Library, Boston University, Boston, Massachusetts.

Problem or Problems.—The purpose of this study is to present an accurate account of the status of the integrated course in physical science in senior high schools throughout the United States.

Steps or Methods.—Teachers of physical science from 40 schools in cities with a population of 5,000 and over contributed information. A preliminary request of every state department of education in the United States for names of cities known to teach this subject yielded results from 24 states. Questionnaires were sent to schools suggested by the Departments. These data were tabulated and analyzed.

Sources of Data.—Questionnaires.

Statistical Treatment.—Comparison of frequencies.

Major Findings.—One hundred secondary schools were contacted and seventy responded: forty offered the courses and thirty were not offering it. The names of the schools were listed; the numbers of pupils taking the subject are given; the total school membership is given. Titles, time allotted, grade level occurrence, number and lengths of laboratory periods, and registration of students in other previous or concurrent science courses are given. Topics covered by the courses are analyzed. A list of all the textbooks used is included.

There seems to be a definite increase in the number of physical science courses offered; more pupils are taking the course. In some places it is not always a substitute for traditional courses in upper level science, although it is usually the non-college preparatory student who is enrolled.

* * *

SACHS, MORRIS NELSON. A Program of Requirements and An Instrument for Appraisal of Science Facilities in Elementary and Junior High Schools in New York City. Ed.D., 1953, Columbia University. Library, Teachers College, Columbia University, New York, New York.

Problem or Problems.—To formulate a justifiable program for providing needed science facilities for science education in the elementary and junior high schools in a Manhattan area in the vicinity of Columbia University.

Steps or Methods.—(1) Estimated future elementary and junior high school enrollment trends. (2) Appraised community and neighborhood characteristics, including housing, socio-civic, recreational, cultural, and related factors. (3) Determined the nature of extent of facilities for science education in the existing school plant. (4) Developed a check list and rating scale to evaluate the adequacy and suitability of science facilities in the existing school plant. (5) Applied these standards to determine the condition of science facilities in the existing school plant, the need for modernization, replacement, new construction. (6) Formulated a policy for priority with reference to needed facilities for an effective program for science education. (7) Developed a program of requirements to meet the needs of the present and estimated future enrollment for a well-rounded science program. (8) Indicated the application of this survey method to determine present and future needs in science education in other geographic areas.

Sources of Data.—Inspections, interviews, expert judgments, questionnaires, reference books, periodicals, textbooks, and courses of study.

Statistical Treatment.—None.

Major Findings.—(1) The majority of schools in the pilot study were inadequately equipped for a program in science education. (2) An instrument for evaluation was prepared which may be applied to the total elementary and junior high school plant.

* * *

SCHROETER, ELIZABETH ARLENE. Earth Science in the Secondary Schools. D.Ped., 1953, University of Toronto. 436 P. Library, University of Toronto, Toronto, Ontario, Canada.

Problem or Problems.—(1) What concepts and topics of earth science are important enough to be included in the secondary school science program? (2) What materials for the development of earth science concepts and topics are available to science students of the secondary schools? (3) What should be the earth science program of the secondary schools?

Steps or Methods.—(1) Topics and concepts of 30 sources were evaluated by 127 science teachers, school administrators, and scientists from all parts of the U.S.A. and Canada. This resulted in 10 topics and 57 concepts of importance for secondary schools. (2) Courses of study and textbooks of 164 representative California secondary schools were analyzed for the evaluated topics and concepts. (3) Earth science problems in the above 30 sources were evaluated by three science men. Topics, concepts, and problems were embodied in a framework for an earth science course of study for secondary schools.

Sources of Data.—Reference books, periodicals, textbooks, courses of study, expert judgments, and questionnaires.

Statistical Treatment.—Mean, standard deviation, coefficient of correlation, critical ratio, and comparison of frequencies.

Major Findings.—There are many earth science concepts suitable for inclusion in the secondary school program. There is considerable variation in the extent of the earth science program in the secondary schools of California. The earth science program of the California secondary schools is concentrated in the junior high school grades. Sixty per cent of the California science textbooks contain some earth science material. Ten topics, 57 concepts, and 908 problems rated important for secondary schools were embodied in an earth science framework developed as a part of this study.

* * *

SILVAN, JAMES C. The Problem Approach in Science Education. Ed.D., 1953, Columbia University. 134 P. Library, Teachers College, Columbia University, New York, New York.

Problem or Problems.—To show the advantages of the problem approach and to suggest methods of locating problems which can be used in a general education course in college biology.

Steps or Methods.—(1) Examination of general education philosophy. (2) Examination and statement of an approach to subject matter selection. (3) Presentation of illustrative materials from entomology.

Sources of Data.—Reference books, periodicals, courses of study, Government reports, commercial advertising, personal correspondence and interviews.

Statistical Treatment.—None.

Major Findings.—It is possible to present fundamental and major areas in biology through the problem approach. It is recommended that (1) an analysis of problem areas be made by the instructor and/or class and (2) student's questions be used in locating and defining problems.

* * *

SIMON, HARRY ARNOLD. A Basic Philosophy of Science Education and Its Application in Biology Teaching. Ed.M., 1953, Cornell University. 87 P. Library, Cornell University, Ithaca, N. Y.

Problem or Problems.—To study the relationships of a basic philosophy of science education to science instruction in the classroom.

Steps or Methods.—Survey of the literature in the area and a questionnaire sent to 100 biology teachers in the State of New York.

Sources of Data.—Questionnaires.

Statistical Treatment.—Percentage.

Major Findings.—(1) Teachers having smaller classes, teaching in rural schools, and having fewer years of teaching experience tended to use more conservative methods of teaching. These same teachers, however, tended to stress the more progressive concepts. (2) There seemed to be no relationship between the use of progressive

methods and the stressing of progressive concepts. However, there was a relationship between progressive concepts and evaluation of methods. Those teachers who stressed the more progressive concepts tended to evaluate progressive methods as effective and conservative methods as not effective.

* * *

SUMMERER, KENNETH H. An Investigation of the New York Regents Examinations in Physics for January 25, 1949, and June 21, 1949. M.A., 1953, University of Michigan. 310 P. Library, University of Michigan, Ann Arbor.

Problem or Problems.—To item analyze and evaluate 1,682 completed and graded Regents Examinations of the University of the State of New York prepared for physics for January 25, 1949, and 2,142 prepared for physics for June 21, 1949.

Steps or Methods.—The Regents Examinations are divided into two parts. Part I is made up of 50 objective-type questions. Part II is also made up of 50 points but essay-type questions were used. The number of right answers obtained by the students on the odd questions of Part I were compared with the even scores on Part I to obtain the coefficient of reliability. The total score obtained on Part I was compared with the score obtained on Part II to obtain reliability of the whole test and was termed coefficient of consistency. The validity of the examinations was determined by comparing the scores made by students on the entire test with those made on certain sections of the test which were considered to measure the major objectives of science education.

Sources of Data.—Examinations.

Statistical Treatment.—Coefficient of Correlation.

Major Findings.—The data failed to show that the Regents Examinations in physics for the dates listed are reliable, consistent, or valid.

* * *

TAPPE, DOROTHY. Junior Museums with Special Reference to Bridgeport Connecticut's Wonder Workshop Junior Museum. M.S., 1953, Cornell University. 40 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—To present the purposes and operation of junior museums with suggestions for their future development.

Steps or Methods.—Search of the literature in the field and a careful study of Wonder Workshop Junior Museum in Bridgeport, Connecticut.

Sources of Data.—Interviews.

Statistical Treatment.—None.

Major Findings.—Junior Museums are highly specialized, but they can provide an exceptional educational opportunity for children during the child's leisure hours.

TELFER, RICHARD GREENWELL. An Investigation of the New York State Regents Examinations in Physics for June 20, 1950, M.A., 1953, University of Michigan. 174 P. Library, University of Michigan, Ann Arbor.

Problem or Problems.—To item analyze and evaluate 2035 completed and graded Regents examinations of the University of the State of New York in Physics. These examinations were prepared for June 20, 1950.

Steps or Methods.—(1) Tallying the scores on the physics examination. (2) Summarizing the results of the tallies. (3) A determination of the reliability of the examinations. (4) A determination of the validity of the examinations. (5) A check of the areas in the syllabus with which the examination deals. (6) An item analysis of the examinations. (7) An analysis of the scoring problems. (8) Summary conclusions, and recommendations.

Sources of Data.—Actual examinations.

Statistical Treatment.—Standard deviation, coefficient of correlation, and Chi square.

Major Findings.—The data in the computations fail to show that the Regents Examinations in Physics for June 20, 1950 are reliable, consistent, or valid, to a high degree. It is generally suggested that the examinations be retained and modified; also that a study be made to improve reliability and validity. A scoring key would be most valuable if provided.

* * *

VINING, HUBERT MAYO. A Survey of the Opportunities For Outdoor Teaching to Enrich the Study of Biology for Junior and Senior High School Students at the Viewpoint School, Amenia, New York. Ed.M., 1953, Cornell University. 51 P. Library, Cornell University, Ithaca, New York.

Problem or Problems.—To present some of the opportunities for the study of biology in the natural settings near Viewpoint School, Amenia, New York.

Steps or Methods.—Field survey of school property and nearby areas.

Sources of Data.—Courses of study and field study.

Statistical Treatment.—None.

Major Findings.—The outdoor experiences suggested for enriching the study of biology emphasized the study of lower forms of plant life, wild flowers, trees, shrubs, birds, mammals, and insects. The proposed field trips were classified as to the season beginning with the fall and progressing to the spring. A Nature Club is recommended.

* * *

WHITE, CHESTER RAYMOND. A Study of Approach-Avoidance Behavior in Relation to Scholastic Accomplishment in Natural Science Study. Ed.D., 1953, University of Pittsburgh. Library, University of Pittsburgh, Pittsburgh, Pennsylvania.

Problem or Problems.—What is the association between the student's evaluation of science as a

subject of study and his accomplishment after study?

Steps or Methods.—Measures of accomplishment in science study, general mental ability, and the student's evaluation of science as an academic study were secured. The measures were studied statistically in inter- and multiple-correlation and factoral procedures.

Sources of Data.—Experimental groups, questionnaires, and standard tests.

Statistical Treatment.—Mean, median, standard deviation, coefficient of correlation, critical ratio, Chi square, comparison of frequencies and analysis of variance and covariance.

Major Findings.—Evaluation of science as a study is a factor that is related to accomplishment and operates in conjunction with mental ability both positively and negatively. On the same levels of mental ability, relative evaluation of science as a subject of study appears to influence accomplishment accordingly. On the same levels of science evaluation accomplishment varies with the levels of mental ability. This indicates that mental ability is a limiting factor and science-value a delimiting factor in accomplishment.

* * *

WHITEHEAD, OREN WENDELL. An Investigation of Selected Factors Related to the Professional Status of the Science Teachers in the Four-Year Accredited High Schools of Texas for the School Year 1952-53. M.S., 1953, North Texas State College. 90 P. Library, North Texas State College, Denton.

Problem or Problems.—(1) What is the background of the science teachers with respect to academic and professional training? (2) What degrees do the science teachers hold and what is the relationship of the degree held to the training received? (3) What kind of certification does the science teacher have? (4) What is the status of the science teachers with respect to the subject matter preparation and the courses taught in the school year 1952–53? (5) What is the official position of the teachers with respect to assignments for the school year 1952–53? (6) What is the status of the science teachers with respect to experience and tenure in teaching science? (7) What is the status of the science teachers with respect to membership in professional or learned societies? (8) What are the trends and tendencies with respect to the status of the science teachers? (9) How does the status of the high school science teachers of Texas compare with the status of high school science teachers in other states and the nation as a whole?

Steps or Methods.—The data concerning student enrollment in high schools were taken from the 1952–53 Public School Directory of Texas. Data concerning the qualifications of the science teachers in the State were taken from questionnaires submitted to a selected group of teachers in accredited high schools. Additional data were taken from related studies. These data were categorized and analyzed to answer the questions noted in the statement of the problem.

Sources of Data.—Questionnaires and Department of Education Records.

Statistical Treatment.—Mean and range.

Major Findings.—(1) There is a shortage of competent science teachers in Texas. (2) Science training in the smaller high schools is below the standard of that found in the larger high schools. (3) Young women, who become interested in science either in high school or in college, should be encouraged to enter the field of science teaching. (4) School administrators should take whatever measures are available to them to retain the same science teachers within their schools. (5) The responsible agency or agencies should take measures to meet financial competition. (6) Teachers who seek an advanced degree, should consider the field or fields in which they teach. (7) The present certification requirements do not in any way assure that those who teach science will have had adequate training in science.

* * *

WOODBURN, JOHN HENRY. Encouraging Future Scientists: Available Materials and Services. Non-thesis, 1953, National Science Teachers Association. Future Scientists of America Foundation, 1201 Sixteenth Street, N.W., Washington 6, D. C.

Problem or Problems.—What are the sponsored incentive programs and career guidance materials and services designed to encourage more high school boys and girls to stay in the paths that can lead to engineering and scientific careers?

Steps or Methods.—An inventory form, prepared by selected professional leaders, was distributed to industrial organizations and educational institutions and through notices in trade and professional journals. Sponsors were invited to submit details in programs and materials being made available.

Sources of Data.—Questionnaires.

Statistical Treatment.—None.

Major Findings.—A bibliography of sponsored programs and materials designed to provide information on scientific careers was prepared.

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WOODBURN, JOHN HENRY. Encouraging Future Scientists: The Situation. Non-thesis, 1953, National Science Teachers Association. 18 P. Future Scientists of America Foundation, 1201 Sixteenth Street, N.W., Washington 6, D. C.

Problem or Problems.—To secure teachers' opinions and experiences with sponsored engineering and scientific career guidance materials and services.

Steps or Methods.—A questionnaire was prepared and distributed to high school science teachers. The 455 usable replies were tabulated and the summary report prepared.

Sources of Data.—Questionnaires.

Statistical Treatment.—None.

Major Findings.—Science teachers did not know about many career guidance materials that were readily available. Teachers welcomed such career guidance materials, services and incentive programs. They were not being informed of the availability of such items. Cooperation with industry does offer science teachers many materials and services that aid in maintaining their own enthusiasm and training, and in arousing student interest in engineering and scientific careers.

* * *

An Additional 1952 Study

ANDREWS, TED F. AND BREUKELMAN, JOHN. Biology Requirements in the General Education Programs of Some Midwestern Colleges and Universities. Non-thesis, 1952, State Teachers College. 5 P. Author, State Teachers College, Emporia, Kansas.

Problem or Problems.—To obtain certain information about biology requirements in general education programs—number of hours credit, year taught, size of classes, laboratory or not, open to biology majors or minors, approach, and emphasis.

Steps or Methods.—Questionnaires were sent to 189 colleges and universities. There were returns from 152.

Sources of Data.—Questionnaires.

Statistical Treatment.—None.

Major Findings.—Biology is more commonly required in teachers colleges than in liberal arts colleges. Usually six or more semester hours are required in liberal arts colleges; five or six in teachers colleges. It is taught mostly to freshmen and sophomores. Separate courses are more common in teachers colleges. Principles approach is predominant. Animals are emphasized more than plants.

An Additional 1951 Study

CARLOCK, JOHN ROBERT. Elementary Science Experiments—A Method of Planning Procedures. M.S. Ed., 1951, Illinois State Normal University. 78 P. Library, Illinois State Normal University, Normal.

Problem or Problems.—(1) To illustrate the planning of experimental procedures that will be in accord with desirable characteristics. (2) To formulate a plan of writing experimental procedures so as to be of greatest value to classroom teachers.

Steps or Methods.—(1) Air Pollution As a Problem of Major Concern was selected to illustrate the objectives of the study. (2) The literature was searched for information concerning this problem. (3) Specific topics under this general problem were selected in which it seemed an experiment might aid in clarification. (4) An experimental procedure was devised, subjected to trial, results evaluated according to the characteristics proposed and acceptable procedures formulated for use by classroom teachers. (5) The experimental procedures worked out involved a model cottrell electrical precipitator, the effect on plant growth of reduced life intensity, and cloud and fog formation and its relationship to air pollution.

Sources of Data.—Experimental groups and control groups.

Statistical Treatment.—None.

Major Findings.—(1) A method of careful planning of science activities related to air pollution and specific direction for repeating these activities are prepared as resources material for classroom teachers.

INSTRUCTION IN TEXTBOOK READING AND ACHIEVEMENT IN ELEMENTARY ENGINEERING PHYSICS AT THE UNIVERSITY OF MINNESOTA *

HAYM KRUGLAK

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1. *Introduction*

THE reading abilities and skills of students have been the subject of numerous discussions and investigations. Thus, Betts [1] in 1945, compiled an index to over 8,000 references to professional literature on reading. The evidence indicates that reading problems are not restricted to pupils in elementary schools and high schools; college students, too, benefit from special diagnostic and remedial measures.

It is also recognized that each type of material requires special reading techniques. Most speakers at the 1946 Conference on Reading [2] expressed the view that the "only safe course to pursue is for teachers

* This study was supported in part by the Committee on Institutional Research, University of Minnesota, through the University Bureau of Institutional Research.

in each field to cultivate the attitudes and skills essential in attaining worth-while goals through reading in their respective fields" (p. 233).

McCullough, Strand and Traxler [3] listed the following criteria of reading maturity in science:

> ". . . the ability to evaluate, verify, and judge the worth of the material; to define with precision words referring to specific substances or operations that can be observed; to describe relationships that can be observed; to select the facts related to a given topic; to picture an experiment from the written description; and to follow directions" (p. 77).

Although most science teachers would accept the above criteria, only a few, if any, teach them explicitly.

2. *The Problem*

The effect of special reading instruction on achievement in elementary engineering physics was explored at the University of Minnesota. The experimental investigation dealt with the following question: *Will students in elementary engineering physics benefit measurably from special instruction in the reading and interpretation of the physics textbook used in the course?* "Benefit measurably" refers to a significant difference in the means on two achievement criteria.

3. *The Population and Sample Selection*

All of the students enrolled in Physics 7, Spring Quarter, 1947 at the University of Minnesota, constituted the population for the investigation. There were originally 284 students in one lecture section and 161 in another section. The great majority of students were male veterans registered in the Institute of Technology. Section I was assigned at random to be the control group; section II constituted the experimental group. Random assignment of individuals to either group was not feasible because of scheduling conflicts.

The criteria of achievement in this study were the final grades in the course and the final scores on the Cooperative Physics Test for College Students-Mechanics, Forms E and F. Two basic samples were selected, consisting of 85 individuals in the experimental and 161 individuals in the control group. This selection was based on the availability of the following information for each student in the basic samples: pre-test score on the Cooperative Physics Test for College Students-Mechanics, high school rank, ACE Psychological Entrance Examination, final grade in Physics 7, and final score on the Cooperative Physics Test for College Students-Mechanics.

To determine whether or not the samples were representative of the population, the variances and means were compared on two variables, which were available for the selected samples: The Cooperative pre-test and the final grade in the course.

4. *Experimental Procedure*

The control group was taught by the conventional lecture-demonstration method. The lecture-demonstration method was used also with the experimental group, but with the following modification. In some of the lectures, part of the time was devoted to the reading and interpretation of the textbook by the instructor. The seventeen reading passages used during the quarter are listed (with explanatory notes) in Appendix I.

The control factors for both groups were: (a) the lecturer; (b) the demonstration; (c) the textbook; (d) the weekly written test—of comparable length, difficulty and face validity and identical instructions to paper graders; (e) the laboratory experiments; (f) the time. The factors which could not be controlled were: (a) assignment to laboratory sections; (b) lecture attendance; (c) the already mentioned individual assignment to experimental or control group.

The final grade in Physics 7 and the raw score on the Cooperative Physics test were used as the two criterion variables, for comparing the effects of the differential treatment. The weekly tests constituted 60 per

cent of the final grade; the laboratory grade, 20 per cent; the final examination, 20 per cent. The letter grades were quantified by assigning a value of 4 points to A, 3 points to B, 2 points to C, 1 point to D, and 0 to F. Forms E and F of the Cooperative test were given as a pretest and a final test.

5. *Analysis of Data and Conclusions*

The means and standard deviations were computed for the experimental and control groups on four variables and the results are shown in Table 1, for "control selected" and "experimental selected."

TABLE 1

MEANS AND STANDARD DEVIATIONS—UNIVERSITY OF MINNESOTA—PHYSICS 7, SPRING 1947

		Variables									
		High School Percentile Rank		ACE Percentile Rank		Coop. Physics Pretest Max. = 50		Coop. Physics Final Max. = 50		Final Grade in Physics 7 Max. = 4	
Sample	Number of Students	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Control-Selected	161	64.96	23.40	54.08	27.04	11.03	5.71	22.16	7.01	1.89	1.01
Experimental-Selected	85	60.59	27.89	52.72	27.61	11.59	5.28	21.51	7.64	1.71	1.12

TABLE 2

TESTS OF SIGNIFICANCE FOR THE DIFFERENCES IN VARIANCES ON COOPERATIVE PHYSICS PRETEST AND ACE PSYCHOLOGICAL EXAMINATION—EXPERIMENTAL AND CONTROL GROUPS

Variable	F-ratio	Degrees of Freedom	P	Hypothesis Tested
Cooperative Physics Pretest	1.160	$n_1 = 84$ $n_2 = 160$	$P > .05$	Accept
ACE Psych. Examination	1.048	$n_1 = 84$ $n_2 = 160$	$P > .05$	Accept

TABLE 3

TESTS OF SIGNIFICANCE FOR THE DIFFERENCES IN MEANS ON THE COOPERATIVE PHYSICS PRETEST AND ACE PSYCHOLOGICAL EXAMINATION—EXPERIMENTAL AND CONTROL GROUPS

(a) "t"-test

Variable	Difference Between Means	Degrees of Freedom	t	P	Hypothesis Tested
Cooperative Physics Pretest	.557	244	.744	$> .05$	Accept
ACE Psych. Examination	1.363	244	.372	$> .05$	Accept

(b) Behrens-Fisher Method

Variable	Difference Between Means	Degrees of Freedom	Ratio of Variances of Means	d	P	Hypothesis Tested
Cooperative Physics Pretest	.557	$n_1 = 84$ $n_2 = 160$	.612	.761	$> .05$	Accept
ACE Psych. Examination	1.363	$n_1 = 84$ $n_2 = 160$	1.985	.369	$> .05$	Accept

The ACE Psychological Entrance Examination was used as a measure of general mental ability; the Cooperative Physics pretest served as an index of the students' background in the subject matter. The F-ratio test showed no significant differences at the 5 per cent level for the variances of the two variables (see Table 2). The *t*-test and the Behrens-Fisher test [4] showed no significant differences at the 5 per cent level for the means of the two variables (see Table 3). Therefore, the experimental and control groups could be considered equated for mental ability and previous knowledge of Mechanics.

hypothesis is accepted at the same level. However, the *t*-table value is entered for a probability of 0.10.

The F-ratio test of significance was applied to the variances of the criterion measure. The results, recorded in Table 4, indicate that there were no significant differences in variances between the experimental and control groups on the final grade in Physics 7 and the Cooperative Physics final test.

The results of the *t*-test for the difference between the means on the two criterion measures are shown in Table 5. Since the null hypothesis was accepted, at the 5 per cent level, the pedagogical conclusion is that there was no significant difference between the conventional lecture and the lecture-reading methods of teaching Physics 7, as measured by the Cooperative Physics final test and the final grade in the course.

TABLE 4

TESTS OF SIGNIFICANCE FOR THE DIFFERENCES IN VARIANCES ON COOPERATIVE PHYSICS FINAL TEST AND THE FINAL GRADE IN PHYSICS 7. EXPERIMENTAL AND CONTROL GROUPS

Variable	F-ratio	Degrees of Freedom	P	Hypothesis Tested
Cooperative Physics Final Test	1.166	$n_1 = 84$ $n_2 = 160$	$> .05$	Accept
Final Grade in Physics 7	1.227	$n_1 = 84$ $n_2 = 160$	$> .05$	Accept

TABLE 5

TESTS OF SIGNIFICANCE FOR THE DIFFERENCES IN MEANS ON THE COOPERATIVE PHYSICS FINAL TEST AND THE FINAL GRADE IN PHYSICS 7. EXPERIMENTAL AND CONTROL GROUPS

Variable	Difference Between Means	Degrees of Freedom	t	P	Hypothesis Tested Null	Hypothesis Tested Alternative
Cooperative Physics Final Test	.655	244	.667	$> .05$	Accept	Reject
Final Grade in Physics 7	.182	244	1.291	$> .05$	Accept	Reject

To test the efficiency of the two teaching procedures, the following null hypothesis was set up: *There is no difference between the mean scores of the two groups on the Cooperative Physics final test and the final grade in Physics 7.* This hypothesis was equivalent to the statement that the two groups were random samples from the same normal population.

An alternative hypothesis was also proposed: *The mean score for the experimental group is significantly higher than the corresponding score for the control group.*

The level of significance was set at 5 per cent. If the null hypothesis is rejected at the 5 per cent level, then the alternative

It is a pleasure to acknowledge the interest and advice of Profs. P. O. Johnson and R. J. Keller. The writer is grateful to Prof. Wm. J. Moonan for reading the manuscript and offering valuable suggestions.

6. *Summary and Conclusions*

a. An experimental study in teaching how to read a physics textbook was con-

ducted at the University of Minnesota with two lecture sections in Engineering Physics 7 (Mechanics).

b. The control group was exposed to the conventional lecture method. Reading and interpretation of the textbook by the lecturer took up part of the lecture time for the experimental group.

c. The samples constituting the experimental and control groups showed no significant differences, at the 5 per cent level, for the ACE Psychological Examination and for the Cooperative Physics Pretest.

d. The experimental and control groups showed no significant differences, at the 5 per cent level, for the Cooperative Physics final test, and for the final grade in Physics 7.

e. If small effects were present, they could easily have been masked by the errors of grading.

f. It would be worthwhile exploring the method with smaller classes and a larger part of the time devoted to reading and interpretations. In addition to the conventional tests, special *reading* tests should be devised.

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4. Johnson, P. O., *Statistical Methods in Research,* New York, Prentice-Hall, 1949 (pp. 69–103).

APPENDIX I

Readings
Textbooks in Physics 7—Spring 1947

Textbook: Hausmann, Erich and Slack, Edgar P., *Physics,* 2nd Edition, New York, D. Van Nostrand, 1939.

1. § 25, pp. 39–41. Silent readings by students —interpretation.
2. Fig. 37, p. 47. Interpretation of graph and simple calculations based on it.
3. Illustrative example I, p. 54; Fig. 41, p. 55—obsolete equipment; Fig. 42, p. 56—Table worked out in detail and graph plotted.
4. Illustrative example, p. 60; § 35, p. 60.
5. First Law, p. 64; § 37, Last paragraph, p. 67.
6. § 41, p. 71—Derivation of equations; definition of *pound* amplified. Illustrative example I worked by $f = ma$; fallacy in the use of $F = \frac{W.a}{g}$ pointed out.
7. Illustrative example II, p. 76.
8. § 49, pp. 86–87; § 50, p. 88.
9. Laws of Angular Motion, P. 93; Illustrative examples I, II, p. 95.
10. Laws of Conservation of Momentum and Illustrative example, p. 122; Illustrative example, p. 188.
11. Illustrative example, p. 115; Illustrative example, p. 120.
12. § 87, p. 154; § 88, p. 156.
13. §§ 89, 90, pp. 156–159; Derivations of Simple and Compound Pendulum Equations.
14. § 119, pp. 204–206.
15. § 126, pp. 215–216.
16. Fig. 166, p. 251—Interpretation.
17. p. 264, Illustrative example; p. 267, Illustrative example.

LEARNING UNLIMITED

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In these days when many things are presented as of a transient nature, and living appears even more impermanent, I think there may be a promising land-stone to ponder.

So long as a good all-round beginning student can sit down and write to tell you on a final examination that the best way to teach conservation is to teach it every day, and then can elaborate on that theme sensibly; so long as your most specialized student who is already marked to go on to greater work is grateful for your help and you well know it; so, as you try to reach out to help all the rest whom, you feel, need even the flippant comment, at times, to help balance their outlook; and even now, as you spring back to your own special niche, it is probably a fact that you have aided some individual in his more bewildering path. This is probably true because you are a teacher.

As you well know, there are many ideas, abstractions, and improvisations indulged in in an attempt to impress learning upon students. You also know that the gaining of factual information has gained great momentum. Factual information in science may be very interesting, but so often it has but little value in itself. Comparisons, contrasts, and correlations are of value.

If a balance in real learning is obtained a a balanced living may well follow. Both learning and living are unlimited in this respect.

Teaching, we have long been told, is an art. Some of us want to teach because we can, thereby, learn more ourselves by selfishly inflicting upon others a lot of unnecessarily unrelated details for our own special benefits. Some of us teach as the stepping-stone instead of the land-stone. It is, then, a thankless job, indeed. Some are the so-called "inspired" (They may be wasting their time!). A few may be the gifted ones who do it in spite of themselves. And some choose to teach because of the real interest in the word. To these last I direct my admiration and admonition. To teach: To make to know how. This is the challenge: To make learning a vital and unlimited effort, a life-long vocation, a thing of beauty and joy and satisfaction. This is the real challenge—whether we are some person designated as a teacher, whether we are a parent, a friend, a member of a fixed community, a neighbor, or just an older or a more experienced individual telling and showing another. Happier is he who can show and to make to know how, for to him comes the real recompense.

PROFESSIONAL TRAINING AND ADAPTABILITY *

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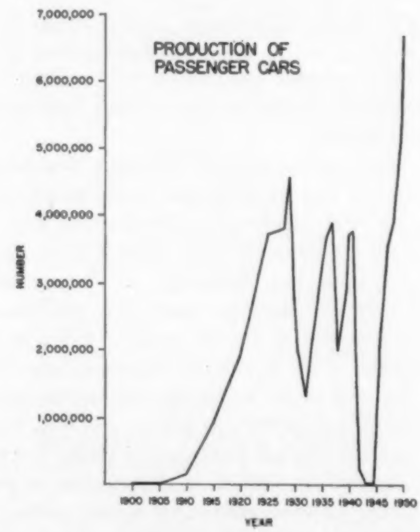
In 1923, I built some 30 crystal sets equipped with earphones and sold them for a profit of about $100. This was my first business venture of any consequence. In 1955, 32 years later, I consulted the World Almanac and sketched the two graphs: (1) the production of passenger cars after 1905, and (2) the installation of home radios after 1923. The two curves are astonishingly similar except for the ups and downs experienced by the automobile industry during the depression and war years. Apparently in 1955, we have not as yet reached the saturation point with regard to these two commodities. We are now experiencing an exponential growth of tele-

* Talk to Educators Club, Topeka, Kansas. February 4, 1954.



vision, which seems to be rising more rapidly than did radio, despite the technical and economic problems which television broadcasting presents. A similar analysis of air travel, would no doubt reveal a like pattern of development in terms of number of passenger miles per year and time per passenger mile. *What we learn from this is that the development of an industry from a zero point to a point of near-saturation covers a period of time smaller than that during which any youth is required to attend school.* Thus, each individual will emerge from school into a world whose technological development and political and social organization differs considerably from that of the world into which he was born. The implications of this and for our own area of special interest, teacher education, are tremendous. Dr. Ridenour of the University of Illinois stated in an address before the American Educational Research Association in 1953 at Atlantic City: "The quality that is predominantly demanded of men and women by the world today is *adaptability*—the ability to adjust oneself to whatever changes may lie in the unknown tomorrows of one's life." * This quality is far more useful than any skill, in a rapidly changing world. The tempo of change in terms of technical developments is far faster than the time-scale used by geologists. Unless we possess this quality of adaptability, the ability to roll with the punches, it is entirely possible that we shall fall victim to environmental changes produced by our own technical skill. This quality of *adaptability* and one more, which I have termed *psychological ownership,* are to my way of thinking the most important attributes acquired during the process of formal education. Those of us concerned with teacher education and the education of youth, must of necessity operate within a frame of reference, or hang our programs on some firmly-fixed hook, in order that we might operate effectively and have faith in what we are

* "Educational Research and Technological Change." Address given before the American Educational Research Association in Atlantic City in 1953 by Louis N. Ridenour of the University of Illinois.

To the writer's knowledge, adaptability as used here was first stated by Dr. Ridenour in his address.

doing. Adaptability and psychological ownership constitute the firmly-fixed hook or frame of reference for planning curricula for teachers and for the youth in our schools today.

Curricula in teacher education and curricula in schools today should produce individuals who possess adaptability and have ownership of what they know. This means that adaptability in individuals is best produced by teaching adaptable understandings which have applications not to the problems of a world that has vanished before the student is out of school, but which have applications to a world which is constantly changing. Adaptable understandings cannot be realized for any one individual unless he has ownership of what he knows and understands. That is, he must use his acquired understandings to meet the changing conditions of his environment and have confidence in this knowledge. Curricula must be designed to give us the soundest possible grasp of principles which are the underpinnings of society today and which will if intelligently applied shape the society of tomorrow. Good education in the fundamentals broadly conceived is the best possible education that can be provided for the best students and possibly for all students on any level of development.

A person becomes an adaptable person possessing ownership of himself if he has through his schooling:

1. Acquired and retained useful and pertinent information of a factual nature.
2. Acquired and retained workable understandings of the principles or big ideas in the various areas of knowledge.
3. Learned to transfer his acquired understandings to meet the problems of everyday living.
4. Reached a level of understanding, application, and performance in the above three commensurate with his native ability.

All these to my way of thinking constitute valid criteria in evaluating the growth of individuals with the purpose in mind of developing adaptable individuals who have ownership of what they know and have confidence through their acquired understandings to meet the changing conditions of their environments.

How might all this be accomplished in the educative process? I believe it can be accomplished through curricula and good teaching that insure that each individual samples widely the various branches of knowledge and that in addition he sinks a shaft of sufficient depth in one area so that he has ownership of what he knows. That is, he must have considerable depth of knowledge in one area and a sufficient base in other areas for further growth and development on his own.

Certainly, curricula patterns on whatever level will not be identical nor should they be. There is no one in this audience who can say, "I know the right way, the only way to produce through education the sufficient man." If I were to say that I had been to Mars, you would no doubt take with a grain of salt my vivid description of what Mars is like. I must remind you that the existing evidence of what Mars is like is still quite limited. Thus, the person who states that he knows in detail the correct procedures in the educative process is talking through his hat. Consequently, we must constantly explore the problem and attempt to improve the process. Hence I would like to say that curricula, especially on the college level should provide the individual with a sound background in a chosen area of specialization and give him a grasp of the major insights of fields other than his own. The man of today can no longer live in a world of science and technology but must have the stamp of the humanities clearly imprinted on his mind and way of living. Benjamin Franklin stated it another way when he said: "The rapid progress true science now makes occasions my regretting sometimes that I was born so soon. It is impossible to imagine the height to which may be carried, in a thousand years, the power of man over matter. We may perhaps learn to deprive large masses of their gravity, and give them absolute levity, for the sake of easy transport. Agriculture

may diminish its labor and double its produce; and all diseases may by sure means be prevented or cured, not excepting that of old age, and our lives lengthened at pleasure beyond even the antediluvian standard. O that moral science were in as fair a way of improvement, that men would cease to be wolves to one another, and that human beings would at length learn what they now improperly call humanity."*

Yes, in a rapidly changing world, a world that changes markedly within a lifetime, within the school lifetime of an individual, there is need for education which will produce adaptable individuals, who do not have the whole of knowledge but who do possess psychological ownership of what they know. It is imperative that America has individuals who can roll with the punches of a crazy world and who are interested in shaping and directing human behavior in sane directions.

These in a subtle combination, my friends, from where I sit, constitute the hallmark of an educated man. Is this not a terrifically challenging frame of reference for us in education?

* Benjamin Franklin to Joseph Priestley in a letter.

RELATIONSHIP BETWEEN THE SCIENCE INFORMATION POSSESSED BY NINTH GRADE GENERAL SCIENCE STUDENTS AND CERTAIN SCHOOL AND OUT-OF-SCHOOL SCIENCE EXPERIENCES *

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It was the purpose of this study to examine relationships, if they existed, between the possession of science information by ninth grade students and certain pre-ninth grade school and out-of-school factors. These factors included variations in home background involving rural, village, or city environments as well as variations in the general social and economic conditions prevailing within the students' homes; sex differences; 4-H Clubs and Scout membership; interest in reading science books; the amount of school science instruction prior to the ninth grade; and intelligence.

The study considered the amount of science information possessed by students upon entering the ninth grade as well as the amount acquired during the course. This design was implemented by giving a general science test to groups of students as they entered the ninth grade and then repeating with an equivalent form of the same test at the end of the ninth grade. Provision was made to acquire an estimate of the gain in science information that may be ascribed to sheer maturity.

Expressed in operational terms, the importance of this study hinges on determining whether or not the content and level of the experiences offered the students in the ninth grade general science course should be adjusted according to the extent to which these students have participated in other experiences prior to being enrolled in the course.

The major limitation on this study is imposed by the measuring instrument used. Only that science information which enables or aids a student to respond successfully to

* Based on the author's doctoral dissertation entitled *An Investigation of the Relationship Between the Science Information Possessed by Ninth Grade General Science Students and Certain School and Out-of-School Science Experiences.* Completed at Michigan State College, East Lansing, Michigan, 1952.

the items on the Read General Science Test[1] is considered in this study. The author concedes that many of the objectives and accomplishments claimed by general science teachers would require other means of identification and measurement.

The Read Test was particularly suited in several ways to a study of this type. The predominant pattern underlying the students' responses is sufficiently clear-cut to aid in the interpretation of results obtained from its use. Regardless of what other experiences a teacher may choose to include in his course, this test gives a reliable and valid measure of the achievement of his students in respect to their ability to handle the information customarily included in the more widely accepted general science textbooks. The test consists of seventy-five multiple choice items.

Basically, the study was focused on the identification of concomitance of factors and the determination of estimates of the degree of this concomitance. If two groups, the members of which differ in some respect to some factor, also show statistically significant differences in mean scores on the Read Test, this is used as evidence of concomitance between that factor in which the two groups differ and the ability to respond to the items on the Read Test. Degrees of correlation are interpreted as degrees of concomitance.

In order to aid in the interpretation of the data gained through this study, the publishers of the Read Test provided certain information obtained from the standardization procedures. The average item difficulty for Form A was 52.61 and for Form B, 52.55. The average validity for the items in Form A was 42.13. The end-of-year mean score of 3,592 students in 56 communities in twenty-one states was 40.79. The average item difficulty for the eighteen life science items was 53.4 per cent, for the nineteen earth science items, 54.4 per cent, and for the thirty-eight physical science items the average difficulty equalled 51.2 per cent. Difficulty in this case equals the per cent of the students in the standardizing group who answered the item correctly.

The students who participated in this study were enrolled in 27 high schools located in large and small cities and villages ranging in total population from that of the small cities to nothing more than a shopping center surrounded by a few farm dwellings. With agriculture so definitely the predominant productive enterprise in Central Illinois, it would be difficult to show that any student in the area would have been totally free from rural experiences through his home and family background.

In addition to taking both forms of the Read Test, the cooperating students completed a questionnaire that enabled different categories of school and out-of-school experiences to be identified. Forty-one teachers cooperated in the study by administering the tests, making the school records of intelligence tests available, and by identifying those students who, in their opinion, came from the "best" and "poorest" homes.

The conclusions that were drawn from this study were based on such data as follow.

	Average Initial Score	Average Final Score
1,973 ninth grade general science students	33.12	41.60
3,592 students in publisher's standardizing group		40.79
198 students who were taught no general science through the year	35.12	37.50
226 tenth grade students who had been taught no gen. sci. in the 9th grade	38.25	42.91
The boys in the 1,973 9th grade group	34.73	43.28
The girls in the 1,973 9th grade group	31.56	40.00
366 Boy Scouts	36.49	44.04
603 Boy non-Scouts	33.66	42.82
399 Girl Scouts	32.97	40.98
605 Girl non-Scouts	30.72	39.32
375 students with 4-H Club experience	34.70	43.72
1,598 students without 4-H Club experience	32.75	41.10
335 rural students	32.22	43.10

[1] John G. Read, *Read General Science Test,* World Book Company, Yonkers-on-Hudson, New York, 1950.

221 village students	33.64	42.43
1,124 city students	33.18	40.87
228 students from the "best" homes	38.85	48.35
140 students from the "poorest" homes	29.95	38.17
254 students reporting "high" interest in reading science books	38.12	46.10
503 students reporting "low" interest in reading science books	31.35	40.08
311 students with practically no science instruction through the 6th, 7th, and 8th grades	30.75	39.27
596 students with a total of about 8 classes per week through the 6th, 7th, and 8th grades combined	34.76	42.72
457 students with at least 4 or 5 science classes per week through each of the 6th, 7th, and 8th grades	33.50	42.10
Correlation coefficient between initial and final test scores		.72
Correlation coefficient between initial score and intelligence		.56
Correlation coefficient between final score and intelligence		.58
Correlation coefficient between individual gains and intelligence quotients		.00

The standard errors of these means may be estimated by using the information that the distributions from which they were computed showed standard deviations of approximately ten raw score points. The detailed statistical treatment of the data may be examined in the original report of this doctoral study found in the library at Michigan State College. An attempt is made here to indicate only the general nature of the data and the generalizations drawn from the study. The more significant of these generalizations follow.

The items on the Read Test are more closely related to the subject matter of the ninth grade general science course than to the tenth grade biology course or to the everyday activities of boys and girls who are enrolled in neither of these two courses.

Students upon entering the ninth grade general science course are already familiar with a worthwhile portion of the science information customarily included in the course.

Whatever it is that gives a student an advantage on the intelligence tests which were used to estimate intelligence also gives the student an advantage in possessing science information prior to enrollment in the ninth grade general science class.

The instructional experiences included in the general science class are of such nature that the intellectually bright and dull students have equal opportunities to gain additional science information.

There is a closer relationship between the subject matter of the Read Test and the everyday activities of boys and girls than between these activities and the exercises in the intelligence tests whereby the intelligence quotients of the students were determined.

Membership in Scout organizations and in 4-H Clubs is accompanied by some factor that gives students an advantage on the Read Test and also on intelligence tests. Eliminate from the relationship between membership in these organizations and Read Test scores the overlapping of intelligence and other factors and there is no significant degree of correlation remaining.

Although the students from the "best" homes possessed significant amounts of superior initial science information, students from the "best" and "poor" homes tended to gain the same amount of science information through the ninth grade general science course. The initial superiority in Read Test scores is virtually overlapped by superiority in intelligence.

The degree of relationship between the science information possessed by ninth grade students and their reported interest in reading science books is greater than the relatedness between such information and any other factor encountered in this study, the intelligence of the students being considered constant. There is no difference in the degree of stimulation toward reading science books offered by the "best" and "poor" homes.

Although there was a significant degree of correlation between Read Test scores, initial and final, and the reported number of science classes through the sixth, seventh,

and eighth grades, it was so low as to be almost negligible. The relationship was found to be non-linear.

There was a degree of negative correlation between gains on the Read Test and the reported number of prior science classes. The value of this correlation was almost negligible and scarcely statistically significant. There was no reason to believe that this relationship was non-linear.

Instruction in the ninth grade general science course tends to close the gap between students who enter the course with a minimum and a maximum amount of prior instruction in science. It follows from this that a student who shows precocious ability in the acquisition of science information is not provided instructional experiences enabling him to maintain his relative superiority.

BOOK REVIEWS

REILLY, WILLIAM J. *Career Planning for High School Students.* New York: Harper and Brothers, 1953. 110 P. $2.00.

Although much more attention is given to career planning in high schools today, it is still true that many high school boys and girls do not receive the benefits of thoughtful consideration in planning their careers, either by school officials or by themselves.

This book shows how successful careers are planned step by step. The author, a noted authority in the field of business and career planning, outlines in detail a scientific procedure by which a student can himself determine the initial step of his career—whether he is going directly into a job, or on to college. Here are self-examination tests, with instructions for their use, by which the student can analyze his desires, abilities, and human relations capacities, and arrive at a sound conclusion regarding his immediate objective.

The author states that the most important consideration in planning one's career is *What You Yourself* really *Want* to do. Don't let money dominate your choice. Don't try to settle your whole life at once.

Chapter considerations are: (1) Getting Off to the Right Start, (2) The Need for Straight Thinking in Career Planning, (3) Observing Your Desires, Your Abilities, and Your Human Relations, (4) Defining Your Real Career Problem and Considering Possible Solutions, (5) Securing Evidence on Possible Solutions to Your Immediate Career Problem, (6) If You're Going to College: Set Up a Definite Schedule, Make Your Schedule Easy to Meet, How to Study, (7) If You're Going to Get a Job: How To Land the Job You Want, How To Get Ahead, How To Get Good Ideas, (8) How To Get Along With People: Think of the Other Fellow's Interests; Admit, Don't Defend Your Mistakes; Avoid Arguments; Look for the Good Points in People; (9) Looking Ahead: Keep Improving the Definition of Your Desires, Keep Improving Your Abilities, and Keep Improving Your Human Relations.

This is a highly recommended book for the high school library, for the high school student personally, and for high school guidance teachers and counselors, as well as classroom teachers.

JOSEPH, E. D. *The Teaching of Science in Tropical Primary Schools.* New York (114 Fifth Avenue): Oxford University Press, 1953. 234 P. $1.20.

This is first of a series of UNESCO Handbooks on the *Teaching of Science in Tropical Countries.* Emphasis is put on methods of teaching and lines of approach to subject matter rather than on the content of a syllabus. The series of books have been designed to advise and help teachers of science, particularly those working in the rapidly developing tropical countries, to give their pupils a better understanding of science as a whole.

Content includes: Preparation for Science Teaching, Practical Work in Elementary Science, Primary School Science Materials, Teaching Science in Each of the Six Years in the Elementary Schools. A chapter is devoted to each year. Content for each year is presented in some detail with detailed suggestions as to how to teach this content, the main ideas to bring out in each topic, the experiments and activities that may be used, and to some extent the science content background needed by teachers.

While definitely British in literary style and approach and in the content suggested as appropriate for the various grade levels, American elementary science teachers will find here a wealth of ideas that they can readily use. This is especially true as regards the demonstrations and experiments. Considering the low cost of the book and its usefulness as a supplementary reference, it would be an excellent addition to every American classroom where science is being taught. There is much we can learn from our English cousins, even in teaching elementary science.

BECK, ROBERT H. COOK, WALTER W. AND KEARNEY, NOLAN C. *Curriculum in the Modern Elementary School.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1953. 584 P.

Elementary science leaders and enthusiastic elementary science teachers everywhere will appreciate the emphasis given elementary science in this book on the elementary school curriculum. The authors state that they "believe that the teaching of science is under-emphasized in the elementary schools. Children should gain an appreciation of the progress made in the field of science and the effect of such progress upon our modern life—scientific habits of thinking and scientific attitudes are a great deal more significant than is the subject matter content of science that they learn, though that is important, too. After all habits and attitudes will remain with pupils for a much longer period than will many of the memorized facts." In accordance with this belief the authors devote two chapters—nearly fifty pages to elementary science.

Part One of the book discusses such factors as motivation, group work and social learning, permanency of learning, evaluation and so on. Part Two clarifies and describes various types of curriculums—their content, strengths, and limitations.

Part Three is especially interesting reading, presenting at some length the school activities of three different teachers in three different communities—illustrating different approaches to classroom work, working with parents, and so on.

The writers take a progressive attitude toward education in the elementary—not ultra liberal or progressive with a big P nor do they assume ultra conservative or traditional attitudes. In general, this seems to be a most useful, practical book both for the prospective and the in-service elementary teachers.

COMMISSION ON EDUCATING FOR AMERICAN CITIZENSHIP. *Educating for American Citizenship.* Washington, D. C. (1201 Sixteenth Street, N.W.): American Association of School Administrators, National Education Association, 1954. 614 P.

This is the Thirty-Second Yearbook of the American Association of School Administrators. The most important American problem has been, now is and will continue to be, the education of America's children for American Citizenship. Through philosophy, suggestions, and examples this yearbook attempts to point out how this may be done most effectively.

Part I on the urgency of aims discusses: The Threat Is Total, Today's Imperative, and the Ideals We Live By. Part II discusses the setting for citizenship education: Mobilizing School and Community and The Individual School at Work. Part III has as its theme instruction for citizenship: Seven Circles of American Citizenship, Meeting Basic Emotional Needs, How Teachers Build Understanding, How the School Builds Attitudes and Ideals, Learning How To Deal with Civic Problems, Practicing Effective Citizenship, and Capitalizing on the Total School Program. Part IV on looking ahead discusses: Evaluating Education for Citizenship, Explorations in Citizenship Education, and What Price Success?

Altogether this is about the best AASA Yearbook so far published and represents an outstanding contribution to American education.

DIEHL, HAROLD S. AND LATON, ANITA D. *Health and Safety for You.* New York (330 West 42nd Street): McGraw-Hill Book Company, 1954. 515 P. $3.76.

Health and Safety for You is designed for use as a high school textbook, either for a year or one-semester course. There are 28 chapters dealing with the more important and significant phases of youth health and safety problems. In format the book is quite attractive, the general appearance appealing, and the literary style most readable for teen-age youngsters. A wealth of charts, diagrams, and other photographs will appeal to the readers and greatly enhance their understanding.

Learning aids include a "So What" summary of the high lights of each chapter; "Checking Up" includes questions for review and drill; "Things To Do" suggests projects, topics for discussion, hobbies and other activities. An up-to-date list of reading material as well as a glossary is found at the end of the book. Altogether this is an attractive book that will appeal to teen-agers and should be most teachable—stressing as it does, problems that should be of great interest and practical value.

Dr. Diehl is Dean of Medical Science and Professor of Preventive Medicine at the University of Minnesota. Dr. Laton is Professor of Health and Hygiene at San Jose State College and a well known member of NARST.

LLOYD-JONES, ESTHER AND SMITH, MARGARET RUTH (Editors), *Student Personnel Work as Deeper Teaching.* New York: Harper & Brothers, 1954. 361 P. $5.00.

Twenty-five authorities contributed to this comprehensive analysis of student personnel work, primarily at the college level. Contributors and topics discussed: Esther Lloyd-Jones *Changing Concepts of Student Personnel Work;* Robert J. Havighurst *Who Should Go to College?;* Raymond A. Patouillet *Continuity in the Educational Process;* Daniel J. Grier *The New Student Arrives at College;* Ruth Strang *Helping The Student to Gain Self-Understanding;* John L. Bergstresser and Dorothy E. Wells *Life Outside the Classroom;* Lucile Allen, Frank Baldwin, Marks Barlow, Jr., and Isabelle J. Peard *Student Participation in Campus Government;* Elizabeth McHose *Learning to Live Healthfully;* William L. Hughes *The Physical Education Program;* Dorothy U. N. Brooks *Where Students Live;* Norman Kiell *Living with*

Students from Other Lands; Paul G. Bulger *Financial Realities and Resources;* Mary F. Longmuir *Moving Toward Marriage and Family Living;* Marion J. Crosby *Planning Vocationally and Finding a Job;* Anna L. Rose Hawkes *Learning More About Purpose-Formation and Self-Control;* Ordway Tead *Developing Spiritual Insights;* George E. McCabe *Utilizing Every Resource;* Thomas B. Shrewsbury *Legal Implications for Student Personnel Workers;* Charles Eugene Morris *Evaluation of the Personnel Workers;* and Esther Lloyd-Jones and Margaret Ruth Smith *The How and the Who and the Why.*

SCHWARTZ, GEORGE M. AND THIEL, GEORGE A. *Minnesota's Rocks and Waters.* Minneapolis, Minnesota: University of Minnesota Press, 1954. 366 P. $4.00.

Minnesota has had a most interesting geological history. *Minnesota's Rocks and Minerals,* written by two members of the University of Minnesota geology department, is intended for amateur geologists, science students, and tourists. Professor Thiel is chairman of the Geology Department and Professor Schwartz is Director of the Minnesota Geological Survey.

The rocks around Saganaga Lake are among the oldest rocks to be found anywhere in the world. The arrowhead granite formations are the residue of what once were mountains many million years ago. Wind, frost and rain wore them down, vast seas engulfed the land from time to time, and finally receded. Minnesota had active volcanoes among its prehistoric mountains. There are beds of volcanic tuff-molten material originally thrown into the air by volcanic explosion. Then came the glacial period and the post-glacial erosion period. The last glacier retreated from Minnesota about 11,000 years ago. The authors explain how the iron deposits on the Mesabi Range were formed.

Geological processions described in the first part of the book outlines geological excursions through Minnesota, telling what features may be seen through these sections. There are 162 illustrations, photographs, drawings, and maps.

CROW, LEONARD R. *Experimental Electricity for the Beginner.* Vincennes, Indiana (1102 Shelby Street): Universal Scientific Company, 1953. 240 P.

Basic concepts of magnetism and electricity are presented in this publication describing and illustrating a total of 194 experiments with magnetism and electricity. The book has been written expressly for use by beginners with no experience in magnetism or electricity. Elementary science teachers, general science teachers, physics teachers, science club sponsors, and teen-age experimenters will find this probably the most ex-

tensive description of experiments in this area. Naturally a number of experiments only slightly vary from similar experiments found in other books. Also a teacher will not be able to use, nor will they desire to use, all of the experiments. A great variety of choices are possible. The directions for experiments are profusely illustrated.

A complete experimental kit of materials for doing all of the experiments is available at relatively low cost of $47.50 or even less. The authors emphasize safety (only six volt current is used—some as in a flashlight—so there is no possibility of a shock) and "learning by doing." The kit is portable and the materials can readily be used by children.

The experiments and operating assemblies include: permanent magnetism, electromagnetism, transformers, bells, buzzers, relays, thermostats, electrical devices, DC and AC electric motors and controls.

Elementary science teachers with this portable, safe kit and experiment book can perform about all the experiments in magnetism and electricity that would be feasible. Safety, simplicity, variety of experiments, nominal costs should permit of wide usage of this set and manual of accompanying experiments. Of course the manual is just as usable without the kit if materials in magnetism and electricity are available to the teacher.

CUNNINGHAM, JR., ROBERT M. *The Challenge of Medical Education.* New York (22 East 38th Street): Public Affairs Pamphlets, 1954. 28 P. $0.25.

The rapid advance of medical science and the mounting cost of medical education, research, and care have brought many problems and responsibilities to the nation's eighty medical schools. Medical education is far more costly than education in most of the other professions. No other kind of education requires so much laboratory space and equipment and so much money to support the all-important dispensary and hospital services for clinical instruction.

This pamphlet discusses early medical schools, medical education in America, developing standards, teaching, research and practice, pay patients and hospitals, the medical curriculum, medical costs support needed for medical schools, and present problems.

PATTERSON, MARGARET E. (Editor). *Science Clubs of America Sponsor Handbook.* Washington, D. C. (1719 N. Street N.W.): Science Service, Inc., 1954. 64 P. $1.00.

This 1955 edition of the *Science Clubs of America Sponsor Handbook* has been brought up to date, retaining many of the fine parts of earlier editions and adding and bringing up-to-date other material. All secondary science teachers should have this book and it is an almost *must* for all sponsors of science clubs.

Contents include: How to Organize Your Science Club, Where Science Clubs Are Located, Activities for Your Club, Co-projects for Your Club, Science Fairs, National Science Talent Search, Affiliated Groups in Various States, Free and Low Cost Material for Science Clubs, Science Projects, and Science Service Aids for Science Clubs.

DRESSEL, PAUL L. AND MAYHEW, LEWIS B. *Science Reasoning and Understanding.* Dubuque, Iowa: Wm. C. Brown Company, 1954. 223 P. $3.50.

This monograph is a project of the Intercollege Committee on Science from seventeen cooperating institutions. The past 25 years have seen a revolution in the teaching of science in the colleges to non-science majors. A variety of approaches have been used in teaching this new type of science—broad survey, historical cases, the problem approach, the "block-and-gap" technique within a single science or several related sciences, and the social implications of science.

This monograph presents the Science Committees findings and thinking. It lists 7 objectives for a college general education course in science. It presents a guide for construction of evaluation items and abilities needed to be developed in students. Popular scientific literature served as bases for construction of a series of four 50 minute tests—two in Natural Science, one in Physical Science, and one in Biological Science.

The first four chapters of this monograph are devoted to discussions of how a specific scientific problem may be treated utilizing textbook materials and current science materials, and specific teaching methods which individual committee members have found valuable. Subsequent chapters contain articles from periodicals (primarily the *Scientific American*) together with suggested evaluation items based upon them. There is a bibliography by Vaden W. Miles dealing with recently published materials relating to teaching and evaluation problems in general education college science courses.

Donald Decker, Leland P. Johnson, Clarence Nelson, Leona Sundquist, and William C. Van Deventer, members of the National Association for Research in Science Teaching, were members of the Intercollege Committee on Science.

SWARTZ, HARRY. *The Allergic Child.* New York (210 Madison Avenue): Coward-McCann, Inc., 1954. 297 P. $3.95.

This is said to be the first book on allergy directed solely to the layman. It should be not only most helpful to parents but also to teachers, especially elementary grade teachers. The book explains the general problem of allergy in children, what allergy is, how it shows itself. It will help parents with an allergic child or the parents themselves if they happen to be allergic.

It is believed there are at least 5,000,000 children under fourteen years of age who suffer

from one of the better known kinds of allergic conditions and probably another 15,000,000 who are subject at times to allergies of some kind. One out of ten people in the United States is an allergic person—one out of every eight children.

Many children are ill from some form of allergy when the illness is attributed to something else—even by the doctor. Only an allergist specialist who obtains a complete history of the case can determine the nature of the allergy and suggest treatment. Allergies may be found in emotionally normal children as well as the neurotic child. Permanent physical as well as permanent mental and emotional harm can result from allergy, unless the allergy is recognized and properly treated. A bad allergy often affects the behavior pattern of children. Thus teachers should recognize this as well as parents.

Seemingly almost every aspect of allergy is discussed in this comprehensive book, including when allergies begin, allergy offenders, emotion and allergy, behavior problems and allergy, nutrition and allergy, things causing allergies (almost anything), common tell-tale signs of allergy, how to prevent and cure allergies, foods causing allergies and foods for allergic persons, and so on.

This is a fine book for not only parents, the general lay reader, but also for teachers, too. Teachers, especially elementary teachers, have to deal with allergic children every day.

NOAR, GERTRUDE. *The Junior High School Today and Tomorrow.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1953. 373 P. $4.75.

This book is designed to describe the underlying philosophy and practices operating in the Junior High School of today with a look at what the Junior High School is likely to become tomorrow. There is need of organizing a junior high school program around the needs and potentials of today's teen-ager. The book is intended to build a curriculum and school that are truly teenage centered. The core type curriculum (integrated subject matter) is emphasized.

Specific procedures, teaching techniques, outlines of subject-matter content are presented. Science receives very scant attention. From the emphasis on the social studies, the author must be a social studies teacher, or former social studies teacher who holds the belief that social studies are easily the most important area in the junior high school curriculum.

Junior high school teachers will find this a most important and useful professional book.

GRIM, PAUL R. AND MICHAELIS, JOHN U. (Editors). *The Sudent Teacher in the Secondary School.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1953. 484 P. $4.50.

All that was said about *The Student Teacher in the Elementary School* reviewed above applies to *The Student Teacher in the Secondary School* —practical emphasis, underlying philosophical basis, meeting the needs of secondary student teachers, and so on. While many of the chapter headings are the same in the two books, the content of course is quite different. This particular book has chapters on Working With Individual Pupils, Solving Your Own Problems, and Your Extra Class Activities.

This book should most adequately meet the needs of student teachers in the secondary schools.

Contributors in this volume come from the University of Minnesota, University of California, Ohio State University, Iowa State Teachers College, University of California at Los Angeles, Hamlin University, and Indiana University.

This is an excellent book for all in-service secondary teachers as well as secondary student teachers.

LONG, FOREST E. AND HALTER, HELEN. *Social Studies Skills.* New York (207 Fourth Avenue): Inor Publishing Company, 1954. 136 P. $1.85.

This is a supplementary textbook for social-studies students in the upper elementary or junior high grades. It is designed to improve pupils' skills in various phases of classroom activity and library work. Science students will find many parts of the book as useful in science as it is in the social studies. There is an individual self-testing key available.

Three new units have been added to this revised edition, first published in 1942: How to Make Current Events Reports, How to Take Notes, and How To Draw Conclusions. Some other units are: How To Use the Encyclopedia, How To Use a Map, How To Use a Dictionary, How To Use An Atlas, How To Read Simple Graphs, How To Read Pictorial Maps and Graphs, How to Prepare A Good Report, How To Make a Written Report, and so on.

WILLIAMS, JOHN K. *The Knack of Using Your Subconscious Mind.* Scarsdale, New York: The Updegraff Press, Ltd., 1952. 104 p. $2.50.

The main thesis of this stimulating book is that people could and should make more use of the subconscious mind in solving the daily problems of complex modern day living. He cites numerous instances where world famous people have solved many of the world's most important problems through use of the subconscious mind—where solutions to complex difficult problems came to them when they were reading something quite unrelated, listening to music, playing a game, walking, or sleeping. In all of these instances the author maintains the solutions were the result of the workings of the subconscious mind when the conscious mind had run into an imponderable wall. Suddenly in a flash, the subconscious mind reveals the solution of the problem.

The subconscious mind does not function unless there has been *thorough,* definite preparation and consideration by the conscious mind plus a *real* purposeful desire to find a solution to some

complex problem. Answers to these problems may come during one's awakening moments, or they may come when one is seemingly asleep. One needs *faith* that a solution is possible—a right solution at the right time. Many people fail at this critical stage. Thus the techniques suggested by the author would seem to be both simple to put into operation and effective in results. Readers may want to try it out.

ROSSOFF, MARTIN. *Using Your High School Library.* New York: The W. Wilson Company, 1952. 75 p.

This pamphlet attempts to take into account the immediate library needs and interests of high school students. An attempt has been made to make it both practical and readable. The approach is to integrate library instruction with the curriculum. First there is an introductory note to students on library values and functions, four units based on typical problems arising out of classroom situations (biography, science, geography, and social studies), a unit on *Preparing A Report,* another unit on *The Problems of Young People* followed by two units on *Choosing A Book to Read* and *Building a Home Library. An Achievement Test in Library Skills* concludes the pamphlet.

This pamphlet should also be of great value to college freshmen as well as high school students. The author is Librarian at the James Madison High School in Brooklyn, New York.

LITTLE, CLARENCE C. (Editor). *Project Mouse.* Deering, New Hampshire: The New Hampshire Chapter of the Jackson Laboratory Association, Inc., 1952. 83 p. $2.00.

Project Mouse was planned and written for the strictly educational purpose of telling what cancer is and how cancer research is conducted, largely with the aid of mice. The Jackson Memorial Laboratory of Bar Harbor, Maine, has been carrying on research in the developing of pure strains of mice for cancer research, and doing cancer research since 1929. Its present animal colonies consist of 150,000 mice, 1500 rabbits, 125 dogs, and colonies of guinea pigs, rats, hamsters, cats, and goats.

Fire in October 1947 practically wiped the laboratory out but it has been developed since then to the indicated size. Much of its work has been in developing pure strains of mice which are supplied to workers all over the world. Pure strains in mice are much better for experimental purposes. Dr. Little himself is pictured with the 219th generation of a strain he started in 1909.

Each year certain talented high school youth with an interest and aptitude in biology are given scholarships to work in the Jackson Laboratory, an unusual opportunity for experience to become a part of the cancer research team. High school science clubs may also engage in a part of this research work by catching and developing pure strains of field mice in their locality. This pamphlet summarizes some of the Jackson Laboratory research, the present progress of cancer, descriptions of field mice, and how science clubs may cooperate in an important undertaking.

WOODWARD, HELEN BEAL. *Washing Our Water: Your Job and Mine.* New York (22 E. 38th Street): Public affairs Committee, 1953. 28 p. $0.25.

Washing Our Water is a timely pamphlet on the need to fight against stream pollution. The problem of stream pollution is a conservation problem in which every American has a vital stake. The problem has not been solved and seems to be an ever-increasingly important one. Many citizens have not realized this as yet and it is really an educational problem in which schools can render valuable service. Case histories of the dangers of stream pollution are cited as well as how certain cities have effectively handled the problem.

This is an excellent pamphlet for conservation and science teachers in the public schools.

The Iowa Tests of Educational Development. Chicago (57 West Grand Avenue): Science Research Associates Specimen. Set $3.00 each.

The Iowa Tests of Educational Development are designed for grades 9 to 13. They are the product of nearly two decades of extensive research and experience and were developed by a group of educators and test specialists at the State University of Iowa under the direction of Dr. Lindquist.

They are a battery of nine objective tests designed to provide a comprehensive and dependable description of the general educational development of the high school pupil.

Over 700 items are included in the battery, each item selected for its discriminating power in the evaluation of the ultimate and lasting results of an educational program. The tests are designed for annual administration to all students in the school regardless of grade classification or course registration.

The nine tests are: Understanding of Basic Social Concepts, General Background in the Natural Sciences, Correctness and Appropriateness of Expression, Quantitative Thinking, Interpretation of Reading Materials in the Social Studies; Interpretation of Reading Materials in the Natural Sciences, Interpretation of Literature, General Vocabulary, and Use of Sources of Information.

There is a general manual for the tests. For each of the nine tests there are answer pads (either hand-scoring or machine scoring), a scoring stencil, and a test manual. There is a "Your Scores on The Iowa Tests of Educational Development and What They Mean" brochure. Specimen sets of each of the nine tests may also be purchased individually.

A brochure on the "Iowa Every-Pupil Tests of Basic Skills" for grades 5–9 is available.

These tests should be very valuable both to entire school systems as well as individual teachers such as science teachers in evaluating either the educatonal growth of the school system or the natural science growth in the school system as the case might be.

COSGROVE, MARJORIE C. AND JOSEY, MARY I. *About You.* Chicago (57 West Grand Avenue): Science Research Associates, 1952. 80 p.

This is a book of information and activities designed to help teen-age boys and girls understand themselves and others. It is a sort of workbook with much discussion of many important problems of youth and many suggested self-testing devices and charts. It would serve excellently for pupils either as a workbook or reference in classes such as "family life education," "home and family living," "common-learnings," and so on.

Chapter headings are: What makes you you, how personality grows, a healthy personality, every one has problems, growing up, you and your family, getting along in school, dating, and planning your career. There is an excellent list of pertinent films, books, and pamphlets.

Altogether this is an unusually fine book for teachers or for individual pupils to be used as a workbook, reference, or source of problems for discussion.

WHITESIDE-TAYLOR, KATHERINE. *Getting Along With Parents;* ULLMANN, FRANCES. *Life With Brothers and Sisters;* MOHR, GEORGE J. *When Children Face Crises;* DIMOND, STANLEY E. *You and Your Problems;* BEERY, MARY, *Guide to Good Manners;* LEWELLEN, JOHN. *Exploring Atomic Energy;* MERRIAM, ROBERT E. AND BETHEA, JOHN W., *Understanding Politics.* Chicago (57 West Grand Avenue): Science Research Associates, Inc., 1952. 40 p., 40 p., 48 p., 40 p., 40 p., 40 p., 48 p. $0.40 each.

All of the above publications (except *When Children Face Crises* and *Understanding Politics* are a *Junior Life Adjustment* booklet. Parents, teachers and teenage youngsters will find these books most interesting and quite practical in answering many problems and questions often asked. The booklets are excellent references for "common learning" courses. Each booklet has a list of books suggested for further reading.

Getting Along With Parents emphasizes the fact that every one has parent problems. It gives some understanding of the causes of parent-children problems. Family democracy, special parent problems, and making friends with parents are other topics discussed.

Life With Brothers and Sisters discusses brother-sister relations with each other and with their parents. They do have many problems, many of which could be solved satisfactorily with a better insight into their nature and possible solution. The problems are discussed understandingly and sympathetically, and one might add, most interestingly.

When Children Face Crises discusses some of the many crises that children may face. Major topics discussed: childhood is not all sunshine, meeting everyday problems, when parents are ill, when children are ill, when parents part, understanding death, and children and the military crisis.

You and Your Problems discusses many of the problems facing boys and girls. Topics discussed: how problems bother people, solving personal problems, solving school problems, solving community problems, solving national and world problems, and can you solve problems?

Guide to Good Manners offers many practical suggestions to boys and girls concerned with problems of manners and most boys and girls have such problems. The booklet discusses good manners at home, school, in public, and good manners and fun, and good manners and dates.

Exploring Atomic Energy is a well-written booklet on atomic energy. Topics discussed include learning about atomic energy, how man learned about the atom, understanding the atomic bomb, peacetime use of atomic energy, the control of atomic energy, and what you can do.

Understanding Politics has an ambitious title. Discussing the more mechanical and historical aspects of politics, the authors do a rather adequate job. Topics discussed include what is politics, our American democracy, how the party system developed, how political parties are organized, choosing candidates, campaigns and elections, and your responsibility as a citizen.

MEREDITH, FLORENCE L., IRWIN, LESLIE W., AND STATON, WESLEY M. *Health and Fitness.* Boston: D. C. Heath and Company, 1953. 339 p.

This is the second revised edition of an unusually fine book. The revision was made by the two junior authors. The late Dr. Meredith was a professor of physical and mental hygiene and public health at Tufts College for many years. She was one of America's best known writers in the field of hygiene. Dr. Irwin is a professor of health education at Boston University and Dr. Staton is a professor of health and physical education at the University of Florida.

There are eight units of unusually well-selected textual material dealing with areas that will especially appeal to high school youth. It considers many of the personal physical health, mental health, and social problems of teen-age youth. Numerous attractive photographs and illustrations supplement the textual material.

Study guides at the end of each chapter includes observations to make; statements to comment on; should you, can you tell which would be better for you personally; what is meant by comment?; is it true, contrast, and explain statements.

This book would serve as an unusually fine text in a high school course in health and hygiene or as a most useful supplementary text in biology and general science. Elementary science teachers will find it an excellent reference, too. The book could serve a most useful purpose in "Common Learnings" courses. Undoubtedly many youngsters will enjoy reading this book "on their own."

GREENBIE, SYDNEY AND GREENBIE, MARJORIE BARSTOW. *Anna Ella Carroll and Abraham Lincoln.* Tampa, Florida: University of Tampa Press, 1952. 539 p., $6.00.

The reviewer was born and reared in a Southern Indiana County adjoining the one in which Abe Lincoln spent his boyhood. We have always been interested in all materials relating to the son of Nancy Hanks Lincoln who lies buried near Lincoln City, Indiana.

To the reviewer, this is one of the most remarkable books relating to Abraham Lincoln or some period or character in American history that we have ever read. It is as challenging and startling a book as one is ever likely to read about the Civil War Period and Abraham Lincoln. When one reads this book, the question is: Why has not the information presented in this book not been made available? It throws an altogether new light on both the Civil War and Abraham Lincoln. A part of the question seems to have only one or two possible answers: deliberate suppression of facts and gross negligence in overlooking certain available information.

The authors have amassed a considerable amount of documentation that seems indisputable. Another person with a major in history agrees with the reviewer in this appraisal.

The authors claim that "Anna Ella Carroll was the greatest woman of America down through the Civil War and perhaps even up to the present day." If the authors thesis presented in this book is substantiated, the reviewer would readily agree with them. And it may be said there is every probability that the claim is truly justified.

Anna Ella Carroll, daughter of a Governor of Maryland was the most gifted, tireless, influential woman who ever lived among and left her marks upon the men who governed the United States at any period.

As a master of political argument, Anna Ella Carroll was one of the most literate propagandist of the Union cause; as a military strategist she surpassed any military or political personage in the Union employ; as a confidant and adviser of Edward Bates, Salmon P. Chase, Winfield Scott, Thomas A. Scott, Edwin M. Stanton, Henry Clay, Robert Breckenridge, and scores of other senators and representatives, she was highly respected for her mentality, her legal training, and her political acumen; and as a possible unofficial member of the Cabinet, she gave advice that Lincoln seemingly incorporated in his messages and planning.

Documentary evidence would seem to prove she conceived and pushed through the War Department the plan for the Tennessee River offensive. Surely she kept Maryland from secession and her papers *The Great American American Battle, The Star of the West* and *Reply to the Speech of the Honorable J. C. Breckinridge* are among the truly great American state papers.

Yes, truly this is one of the most intriguing books a reader interested in American history is likely to chance across in a long time! Possibly future historians will accord Anna Ella Carroll the niche the Greenbie's now accord her.

LOW, A. M. *Electronics Everywhere.* New York: The John Day Company, 1952. 191 p. $2.50.

Electronics Everywhere is a popular presentation of a highly technical phase of electrical engineering. It is intended for young folks as well as adults. Most high school students could read it without difficulty. It is about as a simple account as can be written about a highly technical field. It is completely non-mathematical in treatment.

The place of electronics in modern life can hardly be appreciated until one considers the many numerous everyday appliances that make use of electrons in one way or another. And the war-time uses of electronics are truly amazing. But great as these present-day peacetime and wartime uses of electronics are, the future "possibilities of electronics are so great that it is difficult to restrain the imagination in foreseeing the future—dustless homes, steered projectiles, better house warming, automatic type writers, radiograms that can play a concert from a record no larger than a pillbox, color control, space travel, accurate weather forecasting, instant communication and seeing anywhere in the world," are all in the realm of possibility or even probability.

Altogether this is one of the most readable, interesting accounts of electronics that has been published. The descriptions of the many wartime uses of electronics alone make it a very worthwhile book. It is highly recommended for the science teacher, adults interested in popular science, and for the high school science book shelf. Professor Low is one of England's best-known scientists and writers of popular accounts of technical science—more than forty in all.

LOVELACE, DELOS. *Ike Eisenhower.* New York: Thomas Y. Crowell Company, 1952. 263 p. $2.75.

This is one of the pre-convention books on Eisenhower. A number have been written previously and many more will follow, now that he is President of the United States. This one is more likely to be fair and just in its appraisal of Eisenhower's pre-president accomplishments than many of those that follow. These latter, colored

by political bias, are likely to be either quite critical or overly zealous.

That the appraisal in this book is rather accurate is attested by all that happened during the convention, election period, and the short period of the presidency. It seems to the reviewer that the psychological and character analysis of Eisenhower traits by the author are especially penetrating.

All phases of Eisenhower's life are adequately, interestingly covered. Eisenhower's boyhood was that of many an American boy—no better—no worse, no more promising, no less promising. His interest in sports and his academic work in school were about normal but do seem to indicate the great influence of home training.

As a boy Eisenhower, although excellent in history and mathematics, had little interest in things military. It was two years following high school graduation that he first became interested in going to West Point and that because he had lost an Annapolis appointment. And he had become interested in Annapolis only a short time before because it seemed the best means of obtaining a college education at no financial cost.

Eisenhower's planning and work with his military staff in England before D-Day were again reenacted in his obtaining and planning with his pre-president associates. His post-election presidential activities are quite similar to his military planning.

Altogether this is an excellent book on the life of the world's greatest military leader and who may prove himself to be one of America's greatest presidents.

Smith, Victor C. *Photography Workbook.* Chicago: J. B. Lippincott Company, 1953. 85 p.

Photography Workbook is one of the most timely publications to appear in some time. It should fill a need that has existed for many years. There have been books on beginning photography and workbooks in almost every area of academic knowledge but strangely enough not many, if any, in photography. This book is based on the author's many years experience as a teacher of photography in the Ramsey Junior High School, Minneapolis, Minnesota. The workbook can be used for science classes, photography clubs, science clubs, photography classes, and self-instructing groups.

The workbook provides for carrying on picture-taking, darkroom work, learning and gaining experience, learning how to use equipment, just as beginners would learn anyway. Emphasis is placed upon results. There are 38 units that gradually increase in difficulty and skill development.

Skilled photographers without teaching experience or skilled teachers with limited experience in photography will find this is a practical guide. Science teachers and club sponsors will welcome this important aid to better and more enjoyable science teaching.

Bowler, Stanley W. *Photography for Boys and Girls.* New York: Thomas Y. Crowell Company, 1952. 96 p. $2.00.

Photography in its various aspects is said to be America's greatest hobby. More people take pictures and indulge to a varying degree in other aspects of photography than any other leisure time activity. It is a hobby that begins quite young and continues on to the end of life.

This book is one of the few photography books that have been written primarily for boys and girls. The book is probably best suited for boys and girls of junior high school age.

The authors have attempted to make the book as simple as possible providing simple, easy-to-follow directions for taking and developing good pictures. The book, through easy to read textual material and numerous illustrations, tells step-by-step how to make good negatives and clear sharp prints, with only a few pieces of equipment and some easily obtained chemicals. This developing may be done either at home or at school as a part of the science classwork or as an activity in a science club.

Boys and girls, at home, as members of a science class, or members of a science club, will find this a most practical book in photography. Science teachers themselves will find the book most useful. It is a well recommended book for the science book shelf.

Edel, May. *The Story of People.* Boston: Little, Brown and Company, 1953. 197 p. $3.00.

The Story Of People is an anthropology book for young people—teen agers in junior-senior high school. The book answers and explains many questions boys and girls often wonder about. Why people are all so different yet so alike? How did it come about we have so many different kinds of people? Are some people more intelligent than others? Are some gifted especially musically? Why do we behave as we do? Are the Germans actually superior to most people? This book on anthropology—the science of man—gives scientific answers to many questions about people as people.

Many different people are described and compared—Eskimos and Australian hunters, Indian fisherman of the Northwest, the Bachigo farmers of Africa, Indian farmers in America, and so on.

The Story of People makes it clear that our civilization is a man-made way of living together, grown complex because of our complex ways of getting a living changing as those ways change. Our technical know-how is built upon foundations going back to man's beginnings. This book may convince you that all men are brothers; that other people's ways, very different from our own, have dignity and value.

Dr. Edel, now a home-maker, is an anthropologist who lived alone for nearly a year with the Bachigo farmers in Africa. Much of her descriptive material is drawn from this experi-

ence. This makes for a much more interesting book than otherwise possible. It is an excellent book for the science library, for use in biology, general science, sociology, and "common learnings" courses, and just for the fun of reading and learning.

ADLER, IRVING. *The Secret of Light.* New York: (381 Fourth Avenue): International Publishers, 1952. 96 p. $2.25.

Teen-age boys and girls are introduced to physics and chemistry in this book that integrates content and experiments. Readers are taken step by step from simple observations and descriptions of light phenomena to the complexity of atomic structure and atomic energy. The information is challengingly, interestingly written and the experiments will delight all boys and girls who like to do interesting experiments. Experiments by themselves usually hold most teen-agers interest.

Clever illustrations by Ida Weisburd add much to the charm, interest, and understanding of the textual material and experiments.

The Secret of Light is highly recommended for the science library, for teen-age boys and girls, and elementary science, general science, and physics teachers.

BISHOP, RICHARD W. *Stepping Stones to Light.* New York: Thomas Y. Crowell Company, 1952. 186 p. $2.50.

The story of modern lighting goes back to the time of Thales of Greece, 600 B. C. with his first recorded observations of static electricity. The next step was almost 2,000 years later with the experimental work of Guernicke, Gilbert, Galvani, Ohm, Franklin and others. Successive experimentalists since have built upon the work of their predecessors. Edison, the practicalist, made electric lighting a reality.

Stepping Stones to Light traces these steps in this book for teen-agers. Boys and girls of late grammar school and Junior High School age will find this a most readable and interesting book. It is an excellent book for the high school science library, elementary science and general science teachers.

WALL, GERTRUDE WALLACE. *Gifts from the Forest.* New York: Charles Scribner's Sons, 1952. 96 p. $2.50.

Man's use of lumber goes back to the dawn of his development. For innumerable centuries the task of obtaining it and shaping it to his desired ends was largely an individual one. It is only in the last half century or so that this has become an industrial operation of massive proportions.

Gifts from the Forest in text and pictures depicts the story of lumbering from the selection of trees to be cut until the finished product ending up in a frame house.

This is the best description of one of America's most important industry—lumbering—that the reviewer has chanced across. Skill, hard work, mechanization are evident in this well-written, excellently illustrated book. Most of the pictures by John Calvin Townslen are of actual lumber operations and are usually full-page photographs.

This is a recommended book for the science library shelf.

KIDD, KENNETH E. *Canadians of Long Ago.* New York: Longmans, Green and Company. 1952. 174 p. $2.50.

Canadians of Long Ago is the story of Indians—Indians of the Northwest, Indians of the Plains, the Algonkians, and the Iroquois. The author tells how the Indians came to Canada, how they lived and played, their arts and crafts, their traditions and beliefs.

The Indians gift to the white man include corn, tobacco, squash, beans, maple syrup and sugar pemmican, birch bark canoes, and snowshoes. In this book the author has tried to give as true a picture of the Indians as is possible to determine from a study of Indian life after contact with white men and some of their earlier history from archeological research. It is quite different picture from what most people have of Indians—as being fighting, war-thirsty savages interested only in fighting, killing, and hunting.

One reader said he learned more about the true life of Indians from reading this book than he had ever known before. It is a most interesting, readable book, useful in school and home as an accurate description of the contributions of Indians to White Man's culture and of Indian culture itself. Illustrations in black and white by Sylvia Hahn add much to the attractiveness of the book.

MARRIOTT, ALICE. *Indians of the Four Corners.* New York: Thomas Y. Crowell Company, 1952. 229 p. $2.75.

This is the story of the Amasazi Indians who settled in the mountain area where the four corners of Arizona, Utah, Colorado, and New Mexico meet—hence the name. Definite records date back to 11 A. D. and it is most probable that they first came to this region as early as 1000 B. C.

The Amasazi developed a complex culture some phases of which did not change for many centuries. These early Indians were not a warlike people but quite the contrary. They were often raided by more war-like tribes and finally due to these recurring raids plus a great drought beginning about 1276 A. D., the Amasazi moved southward to Arizona and New Mexico. They left us written records but many aspects of their culture have been handed down so that authentic records do date back to 11 A. D. At that time

they were seed gatherers and hunters, storing their food in pits and cooking it in baskets. They lived in brush shelters. They did not catch or eat fish. Between 300 and 500 A. D. they learned to grow corn and beans, lived in pit houses and made baskets, sandals, and fur cloth. From 500 to 700 A. D. beans were planted, bows and arrows were introduced, turkeys were domesticated, separate storehouses were built and walled towns developed between 700 and 1050 A. D. Weaving and pottery reached high development between 1050 and 1300. About 1276 they began to move South because of a great drouth and Indian raids. The descendents of the Amasazi are the present Indians of the Southwest.

Altogether this is a well-written, interestingly told story of the life and development of one of the earliest American cultures.

CRAIG, MARGARET MAZE. *Julie.* New York: Thomas Y. Crowell Company, 1952. 247 p. $2.50.

Julie is the story of one girl's life in college that will be appreciated by those teen-agers thinking of going to college or are now in college. Many of Julie's problems are familiar to all college students and she had plenty of them! Some she solved satisfactorily, others were not solved so satisfyingly. With courage and common sense, Julie solved her problems of loneliness, discouragement, girl-and-boy relationships. You will often criticize Julie's solutions to her problems and at other times praise her decisions. You will wonder what she sees in Greg Peterson and fails to realize the true worth of Tim Ryan and Petey Orcutt—the failure of Julie and her roommate Fran Powers to understand and get along with each other, her droll friend Cynthia and Vi Moore's tragic solution to college problems.

The book is written in an appealing literary style that is understanding of young college people and their problems. This is an excellent book for upper class high school students and college teen-agers.

SHORE, MAXINE. *The Captive Princess.* New York: Longmans, Green and Company, 1952. 309 p. $3.00.

This is the story of the first Christian Princess of Britain, Princess Gwladys Ruffyd, later given the name of Claudia by the Emperor of Rome. The time is the first century A. D. and describes the life and conditions in Britain at the time of the Roman invasion. After years of warfare and suffering, trying to drive the Romans out, the Britains are finally conquered and certain ones are taken as prisoners to Rome. Among these are Princess Gwladys, King Corodoc, Queen Eigen, and Prince Llyn (Linus). Emperor Claudius frees them upon their arrival in Rome but they are not permitted to leave Rome. In Rome they again meet their cousin Princess Pwmpa (Pomponia) who had been captured earlier by the Romans, but was now married to a Roman Senator.

Interwoven with this story is the story of the early Christians in Britain and Rome—woven around the lives of Illid, Joseph of Arimathea and Tirzah—Israelite missionaries.

The first century is one of the most interesting in history and in this story the author has been able to picture the Christian ideals as they must have appeared to people of other faiths. In the Druid training of Princess Gwladys there had been strength and discipline and reverence, but there had also been curses and revenge for one's enemies; prayers for loved ones and country. We see the concept of Christianity through their eyes and Gwladys comes through gradual realization to find that this new faith in a God of Love can bring inner security, sustain a poor slave girl, soften the heart of a haughty Roman soldier. Love and faith come alive in this story.

In Rome, Gwladys marries her Roman captor Captain Pudens who is also an early Christian. The meetings of early Christians in Rome, of Gwladys, King Corodoc, and Llyn's conversion to Christianity. The Pudens are good friends of Paul of Tarsus with whom Paul stays during his trial in Rome. It is a most readable story based upon much historical research and as accurate a description of first century life in Britain and Rome as the author could describe it. A great deal of science, history, social customs, and developing Christianity are blended together to make this a story most readers will thoroughly enjoy.

FERNALD, HELEN CLARK. *Plow the Dew Under.* New York: Longmans, Green and Company, 1952. 299 p. $3.00.

This is the story of the Palevskys-Ilya, Nicolas, Sophie and Bernard, John and Owen Lessing, Don Sebastian, Irina Baronova, William Rockhill Nelson who founded the Kansas City Star and the development of Kansas into the Wheat State of the Union. The Palevskys and the Baronovas were among the Mennonites who came to Kansas in the 1870s bringing with them the strange dress and ways of all foreigners, but most fortunately for Kansas the hard winter wheat from the Russian Crimea—a cold, rust, insect resistant wheat, that was the eventual forerunner of the wheat of present day Kansas.

This is also the story of the resistance to change, the clinging to old customs, manners, and dress by the older emigrants, the acceptance of the new by the younger emigrants and their difficult path between the old and new ways of life. It is also the story of the intolerance by *Americans* of everything and everybody *foreign.*

Ilya wanted to be a business man and his father Nicolas who so loved wheat and the land, wanted him to be a farmer. Ilya won out, becoming a prosperous maker of hard-wheat crackers and, later, pastries.

Altogether it is a fine book on important phases of American development—the assimilation of the emigrant and the making of Kansas as the great wheat center of the world.

ALLEN, MERRITT PARMELEE. *Johnny Reb.* New York: Longmans, Green and Company, 1952. 250 p. $2.75.

This is a story of one phase of the Civil War—built around the lives of Ezra and Festival Jones, two of the men in the cavalry unit of Generals Wade Hampton and Jeb Stuart. The courage, heartaches, humor, the awfulness of war are vividly portrayed. The Civil War was not of the short-duration nor the glory that Ezra and Festival at first thought it would be, but a terrible thing of starving, freezing, dying, and they came to hate it more and more and see it through to the bitter end. Both fight more because of personal loyalty to General Hampton than a belief in the cause of the South.

Boys will enjoy reading this book although it portrays mostly the seamy side of war and how soldiers must react to it in order to endure it at all.

WILLIS, PRISCILLA. *Alfred and the Saint.* New York: Longmans, Green and Co., 1952. 179 p. $2.50.

This is the story of a fourteen-year old boy Alfred and his love for horses, and especially for one called The Saint. Alfred is a mute, and though he can hear, he cannot speak. Alfred works with his father Mr. Timmons, Hank, and Cleveland in taking care of the horses of the Middland Valley Hunt Club.

One day The Saint has a heart attack and his owner orders him to be destroyed. Alfred cannot bear to see this done and persuades his father to let him keep him. With understanding care and training, and with the help of Fanny, the eighteen-year old daughter of Mr. Forsythe, the owner of The Saint, Alfred, Hank, and Cleveland, The Saint becomes perfectly sound again. Mr. Forsythe gave The Saint to Alfred and Alfred's faith in The Saint is justified when he wins a great race against stiff competition.

Altogether this is one of the finest stories of a boy and a horse that the reader has ever read. Moving, humorous, all boys and most girls will enjoy this book as one of the finest stories they have ever read. It is a fine story for character education, too.

MYATT, E. D. *Rim-Rocked.* New York: Longmans, Green and Company, Inc., 1952. 215 p. $2.50.

Juveniles, especially boys, will thoroughly enjoy this story of life in the present day West. It is the kind of a story that will grip a boy's interest so that he will be unwilling to lay the book down until he has completed reading it. It is an excellent book for teaching boys ideals and character. The conversational literary style of the author, with a minimum of descriptive material, will appeal to all boy readers. The author, Mrs. Mygatt, really knows and understands boys, how they react and think. Her own four sons gave her a deep insight into the psychology of youth.

In brief, it is the story of Dave, his brother Stuart, and a friend name Ned, who are in a Connecticut boarding school. After school the three set out in an old car they call Blue Boy. Each of the three boys are quite different in their abilities and each is afforded an opportunity to use his especial talents.

Owner of the ranch in Wyoming is Rocks McGinnity, who cares little for ranching and knows next to nothing about finances. The ranch is about to be sold because of a heavy mortgage. Vanadian and uranium ore are discovered on the ranch and save it from being sold.

The reviewer can hardly imagine a teen-age boy that would not thoroughly enjoy this grand story of life on a ranch in the present-day West.

POWELL, MIRIAM. *Jareb.* New York: Thomas Y. Crowell Company, 1952. 241 p. $2.50.

Jareb is a story of people who live in the loblolly turpentine region of southern Georgia. The story is built around the life of a boy named Jareb and his worthless hounddog, Sawbuck. It is the story of the fight for existence on the part of a poor, proud people—the story of pine forests, the men who destroyed them, and the introduction of new ideas of conservation through replanting and tree culture.

The conversation is in the speaking style of the natives of the region—uneducated but not unintelligent, as well as God-fearing men and women.

Not a book to use as an English model, it is a book that is true to life of a section of American culture. You will laugh and cry as the characters of the book seem almost real. A lot of other people could copy their philosophy and beliefs to their own betterment and that of the rest of the world.

JACKSON, C. PAUL. *Clown at Second Base.* New York: Thomas Y. Crowell Company, 1952. 250 p. $2.50.

Clown at Second Base is a story about America's greatest sport—baseball. Like some players in real life, Bucky Bushard's clowning had spoiled his first big-league chance. Now, four years later, he was having one more chance as second baseman for the Detroit Tigers. But he always had a "gimmick" for poking fun at his teammates, his opponents, his manager, and the umpires. Naturally this kept him in continual hotwater, both to his own and the team's detriment. Gradually Bucky learned to control his tendencies to clown and became a valuable asset to his team.

Altogether this is a baseball story that will interest all baseball fans and is an excellent book for boys in portraying character development, the importance of team play and the harmfulness of individual selfishness.

HEINLEIN, ROBERT A. *The Rolling Stones.* New York: Charles Scribner's Sons, 1952. 276 p. $2.50.

The Rolling Stones is a science-fiction story. It is a story that most boys will enjoy and every boy interested in aviation and interplanetary travel. It is a most readable science fiction book.

The main characters are the seventeen-year-old twins, Castor and Pollux, their sister Meade, small brother Lowell, Mother and Father Stone, and Grandmother Hazel. The Stone's are residents of Luna, the twins having been born there. This story concerns their recreation trip in the space-ship *The Rolling Stone* to Mars and the Asteroids.

The author is one of America's best known writer of science fiction for boys. Among his earlier science fiction books are: *Farmer in the Sky, Between Planets, Red Planet, Space Cadet, Rocket Ship Galileo, Beyond the Horizon, The Man Who Sold the Moon,* and so on.

HELMERICKS, BUD. *Oolak's Brother.* Boston: Little, Brown and Company, 1953. 144 p. $2.75.

Partly fictioned, but more factual, the author describes the experiences of a young brother and sister spending a part of the winter with a family of Alaskan Eskimos. The experiences and descriptions are as factual as possible. The author has lived with Eskimos himself and knows the Eskimo life and environment.

Bob and Jeanie Hamilton live with the Kisik family, the wife Weinyuk, the boy Oolak and the girl, Eva. The two youngsters learn how Eskimos live, how they travel, how and what they eat, how they build their homes, make their clothing, how they fish and hunt, how they weather Arctic blizzards, and so on.

Bob and Jeanie have an experience that boys and girls will enjoy, albeit vicariously. This is an excellent book portraying Eskimo life from the youngster's viewpoint. It would serve excellently as supplementary reading and as resource material for a unit on Eskimos. In this regard, the detailed drawings showing the construction of umiaks ("skin" boats), boots, parkas, pants, dog sleds, ice cellars, dog harness, camps, camp arrangement, snowshoes, fish nets, ice houses, trail camps, and so on, will be of great interest.

WEINGAST, DAVID E. *Franklin D. Roosevelt: Man of Destiny.* New York: Julian Messner, Inc., 1952. 184 P. $2.75.

Many books and articles have been written about Franklin Delano Roosevelt. Many more will be written in the future. This particular book briefly sketches the life of a "man of destiny." This description, not original with the author, aptly describes the author's attitude toward his subject. Unquestionably Roosevelt himself long considered himself exactly that. Only such a belief could adequately explain many of his actions and attitudes.

The author is unquestionably an enthusiastic and partisan admirer of FDR and so this biographical sketch is written through rose-colored glasses so to speak. Many other writers have written similarly, so that is not an unpardonable sin. As an unbiased biographical account, this book is not. As a future source for objective, unbiased information, it will need to be read with the greatest caution. Favorable material is exploited and unfavorable either passed over entirely, mentioned only slightly, or so slanted as to become actually favorable.

On the other hand, realizing the biography has been written by a seemingly enthusiastic follower, the biographical sketch is written interestingly and many personal incidents are brought out. It plays up the best side of its subject and much can be said for that viewpoint. Roosevelt was and still is a hero to many millions of Americans. He will probably remain so for many years to come. The book will serve excellently as a reference and resource book and also as an interestingly written biography of a world-renowned American.

COLBY, C. B. *Ships of Our Navy, Danger Fighters, Submarine, and Air Drop.* New York (210 Madison Avenue): Coward-McCann, Inc. 1953. 48 P. each; $1.00 each.

The above four titles are included in the noted Colby series of books for all ages, on American fighting forces. The author is an associate in the U. S. Naval Institute. The series are characterized by authoritative, brief commentary, and numerous excellent photographs. The latter have been most carefully selected. Juveniles, especially boys, will take a particular delight in the books. However, they should appeal to all Americans regardless of age level because we should all be interested in and take pride in the various units of our fighting forces.

Ships of Our Navy includes carriers, battleships, destroyers, and landing craft. The 44 photographs are official U. S. Navy Photographs. They include the most important, interesting, and sometimes least known types. Below each photograph is interesting information and descriptive material about that particular ship or class of ships. The U. S. has 170 different designations of ships and boats.

Danger Fighters is the story of the men and ships of the U. S. Coast Guard. Dating back to 1790, the Coast Guard has been a very important phase of American Fighting Forces. It seemingly does most all sorts of things from rescue work, protecting life and property at sea, conducting the ice patrol, protect fishing, to enforcing maritime customs, immigration, and

other federal laws. The more than forty photographs are official U. S. Coast Guard photographs.

Submarine tells the story of the men and ships of the U. S. Submarine Fleet. The more than forty photographs and accompanying textual material make this an unusually interesting book.

Air Drop is the story of men, weapons, and cargo by parachute. This is a relatively new addition to American fighting forces but now a very important one. As usual there are numerous and unusually fine photographs.

EVANS, EVA KNOX. *Why We Live Where We Live.* Boston: Little, Brown and Company, 1953. 151 P. $3.00.

This book attempts to explain why each of us live where we do. It is a long story that had its beginning in the earth's ancient past. After certain desirable physical conditions attained, habitation became possible on the earth. Oceans, glaciers, and mountains each had an important place in determining where people found it possible to make a living. Climate, geographic factors, natural resources, cultural, economic, social factors, and occupational opportunities have been determining factors of varying importance in determining where each of the 160,000,000 Americans live. The author has a book with a somewhat different slant explaining why peoples live where they do. The book would serve for interesting supplementary reading for teen-agers of the junior-senior high school level.

EWART, JOHN L., GRAVES, ED., HERRALA, LEO, KEITH, CHARLES, and PATCH, DELLA. *A Guide for Self-Improvement in Science Teaching.* Portland, Oregon: Portland Public Schools, 1953. 29 P.

All of the Guide except the last two sections was developed during the summer of 1953 at the Northwest Institute for Science Teachers, Oregon State College, Corvallis, Oregon. Dr. Donald W. Stotler, Supervisor of Science, Portland Public Schools, served as consultant.

This pamphlet discusses how classroom teachers of science may gradually change from traditional science teaching to more progressive methods and some of the frustrations in changing to modern science teaching. Specific techniques are suggested for bridging the gap from a textbook unit type of teaching through a teacher unit, through a resource unit to an experience unit type of teaching.

Specific types of usefulness of a variety of teaching techniques are given for (1) an individual assignment, (2) a group assignment, (3) committee work, (4) debate teams, (5) demonstrations, (6) discussions, (7) experiments, (8) science fairs, (9) field trips, (10) lectures, (11) panels, (12) plays, (13) projects, (14) reports, (15) science clubs, and (16) sociodramas. Specific evaluation techniques for each of eight important science objectives are given.

Junior and senior high school teachers of science will find this a most useful, practical pamphlet in self-improvement of their science teaching.

FENTON, CARROLL LANE and FENTON, MILDRED ADAMS. *Riches from the Earth.* New York: The John Day Company, 1953. 159 P. $2.75.

Riches from the Earth is another of the series of books by the Fentons on the earth, its minerals, and its rocks. This book traces the story of some of our best known mineral resources. Some of these are rare, others are found in abundance. Briefly, the authors trace the origin of minerals in ancient times, tells how they are taken from the ground and made useable, and describes their more important uses.

The minerals discussed and illustrated include: rocks, ores, and minerals in general; aluminum; asbestos; borax; clay; coal; copper; feldspar and quartz; fluxes; gems; graphite; gypsum; iron; lead and antimony; limestone and dolomite; magnesium and titanium; mercury; mica; nickel; oil and gas; salt; sand and gravel; silver and gold; sulphur; talc and soapstone; tin; tungsten; uranium; and zinc.

The book is suitable for teen-agers and should be an excellent resource book for the high school chemistry class. Elementary science, general science, and chemistry teachers will find this book an easy, accurate reference.

LAWSON, ROBERT. *Mr. Revere and I.* Boston: Little, Brown and Company, 1953. 153 P. $3.00.

This is an unusual book—a sort of "history on the lark." It reads much better than one might assume. Interest mounts as one reads along and finally it becomes an unusual bit of historical writing, based on known historical facts. It is on certain episodes in the career of Paul Revere as revealed by his horse Scheherazade, better known as Sherry. Paul Revere is revealed as a most human individual and Sherry as a most unusual horse. Boys and girls may especially enjoy this type of history reading!

CRISP, FRANK. *The Sea Robbers.* New York (210 Madison Avenue): Coward-McCann, Inc., 1953. 247 P. $2.75.

This is an adventure story of modern sea-pirates using modern scientific advances to advance their nefarious activities. The Australian cargo ship *Kwantung* carrying a valuable pearl consignment is sunk without leaving a trace and all crew-members and passengers killed by the McTaggert pirates. Dirk, a pearl diver and salvager, escapes. Tracing the pirates, Dirk gets a job aboard the pirate ship *Kestrel.* After holding up the ship *Empire Warrior* and obtaining about four million dollars of gold, a hurricane sinks the pirate ship *Kestrel.* Dirk and his friends recover the gold from the sunken ship and receive a large reward.

Boys will thoroughly enjoy this modern story of sea pirates which has sufficient plausibility to assume such an incident could happen, even in this day of modern science detection.

ASSOCIATION FOR CHILDHOOD EDUCATION. International. *Songs Children Like.* Washington, D. C. (1200 Fifteenth Street, N.W.): Association for Childhood Education, International, 1954. 48 P. $1.00.

This is a compilation of folk songs from many lands made by the ACEI in cooperation with the Division of Christian Education, National Council of the Churches of Christ in the United States of America. There are 71 songs with words and music. Twenty-one countries are represented in the list of songs selected. Songs for many different occasions are represented. Elementary teachers will appreciate this compilation both for the variety and the selectivity as well as the enjoyment the children will experience in singing the songs.

LEONARD, EDITH M., VANDEMAN, DOROTHY D. AND MILES, LILLIAN E. *Counseling With Parents.* New York (60 Fifth Avenue): The Macmillan Company, 1954. 330 P. $3.75.

Counseling With Parents has as its subtitle *In Early Childhood Education.* The latter is indicative of the area especially discussed. In the book, Jane LeRoy describes the way in which she initiates and carries through a program of counseling with the parents of her group. Her straight-forward discussions in the first person, presenting the classroom teacher's viewpoint, are intended to show with some vividness the implications of counseling in action. Not trained as a counselor, Jane's experiences dramatize the work of teachers everywhere who are striving in practical ways to carry out principles of counseling to the best of their ability.

The book should be of great value to practically every class room teacher in the elementary grades—not to say that junior high school and senior high school teachers would not profit immeasurably from reading this book. Much practical psychology, education, guidance, and counseling material is included.

SHANE, HAROLD G. AND MCSWAIN, E. T. *Evaluation and the Elementary Curriculum.* New York: Henry Holt and Company, 1951. 477 P. $4.40.

In a sense, evaluation of the elementary schools is relatively recent. It means an examination and appraisal of the goals and practices of the elementary schools. Part I of this book is concerned with helping evaluators in the local school system clarify their values and establish procedures for determining which of the goals suggested by these values have been realized. Part II is designed to help persons in local districts examine the school experiences their program provides for children.

The first part of the book discusses the need of evaluation in elementary schools, values to be sought with children in elementary school, the nature of evaluation and its function in improving elementary education, and evaluation as applied common sense.

The evaluation of specific subject-matter areas is considered as well as certain other larger aspects of elementary education such as leadership, community relations, and so on. There is a very interesting chapter on evaluation of the elementary science program. A list of criteria for appraising children's science experiences is included. Six approaches to elementary science are described.

At the end of each chapter is a list of recommended readings. The appendix is of unusual significance: a summary of the development of evaluation in education, a list of criteria of good citizenship in behavioral terms, and an annotated bibliography of evaluating instruments and related materials.

In general this is a very fine book on elementary school evaluation and practices. The authors are professors of education at Northwestern University, Dr. McSwain also being Dean of the School of Education.

KYTE, GEORGE C. *The Principal at Work.* Boston: Ginn and Company, 1953. 531 P. $4.50.

This is a revised edition of a book first published in 1941. It has had extensive usage and covers most completely the functions of the elementary school principal—organization, administration, supervision, and appraisal. Many of the most routine duties of the principal are discussed.

Prospective as well as principals-on-the-job should find this a most practical and authoritative book. It is based on the author's experience as a principal and in his many years of teaching a course on which the text is based. In this course he has had the benefit of the experiences of many elementary school principals. Specialists have criticised various parts of the text.

Altogether this is an excellent book that will be of great value to elementary-school principals as well as superintendents of school and elementary classroom teachers.

MORPHET, MABEL VOGEL, WELDON, VIVIAN AND WASHBURNE, CARLETON. *Winneka Chart for Determining Grade Placement of Children's Books.* Philadelphia: Division of Publications, The Reading Clinic Department of Psychology, Temple University.

The Winnetka Readability Chart not available for sometime, is now available. The chart on one side lists the 1500 commonest words in alphabetical order with a space for listing uncommon words. The reverse side of the chart lists specific step-by-step directions for grading a specific children's book. Rules for tabulating derived and special forms of words are included. Exceptions to rules in uncommon words and rules for simple sentences are included.

Many persons such as reading specialists, curriculum workers, research students, writers, and others will appreciate the availability once again of this chart.

MICHAELIS, JOHN U. AND GRIM, PAUL R. (Editors). *The Student Teacher in the Elementary School.* New York (70 Fifth Avenue): Prentice-Hall, Inc., 1953. 433 P. $4.50.

Student teaching is the busiest and most profitable experience in a student's program. Information, understandings, techniques and points of view developed in preceding professional experiences must be brought to bear upon instructional problems in a down-to-earth, realistic manner.

There has long been a need for this type of practical handbook for student teachers in the elementary grades. While the emphasis is upon practical techniques, as it should be, there is an underlying philosophical basis: This book should definitely be available to every elementary-grade student teacher. Even in-service classroom teachers will find here a wealth of suggestions on improving their own classroom practices. Here they will find many ideas they do not like to ask their principal or supervisor, and there are many aids mentioned that the principal or supervisor does not know about.

Content includes: Your Beginning as a Student Teacher, Preparation for Student Teaching, Studying Your Children, Making Plans for Teaching, Planning the Unit of Work, Self-Discipline and Group Behavior, Using Group Process, Helping Exceptional Children, Using Community Resources, Using Audio-Visual Materials, Making Audio-Visual Materials, Evaluation of Children's Learning, and Growth in Service.

This is a book that should have definite appeal to the student teacher, rich in suggestive techniques as it is, and answering so many problems confronting student teachers. Contributors come from such schools as University of California, University of Minnesota, University of California at Los Angeles, Oakland, California, and Indiana University.

BLUEMEL, C. S. *Psychiatry and Common Sense.* New York (60 Fifth Avenue): The Macmillan Company, 1954. 259 P. $3.00.

This book emphasizes personal psychiatry. It is hoped that the book may be of practical value to the general reader in helping him cope with his own problems. People are different and it is on this basis that the author attempts to show how individuals can make adjustments in their daily lives. Body functions are often disturbed along with the emotional stress.

Many case histories, illustrative of the various and varied types of emotional disturbance are cited. The book is interesting, well-written in a literary style comprehensible to most laymen.

The author is an M.D., formerly Medical Superintendent of the Mount Airy Sanitarium, Denver, Colorado. He is a Fellow in both the American College of Physicians and the American Psychiatric Association.

DANTZIG, TOBIAS. *Numbers: The Language of Science.* New York: The Macmillan Company, 1954. 340 P. $5.00.

This is the fourth revised and augmented edition of a book first published in 1930. The book has been brought up to date and Part Two *Problems, Old and New,* has been completely rewritten.

The book is intended for the intelligent and cultured layman and there is an almost complete avoidance of mathematical technicalities. Numbers constitute a universal language and the author, in a most readable literary style, unfolds the dramatic story of the development of mathematical concepts. Man's cultural, scientific and technical development could not have taken place without a preceding development in mathematical concepts.

High school and college teachers of mathematics as well as laymen interested in mathematics will find this an unusually fine book on the cultural development of mathematics.

BAILEY, L. H. *The Garden of Bellflowers in North America.* New York: The Macmillan Company, 1953. 155 P. $5.00.

Bellflowers, or Campanulas, in spite of their many advantages have been neglected in the garden literature of this country. These beautiful plants are especially suitable for home gardens. They are easy to grow and their pleasing blues and near blues add quiet charm to home landscapes. The author describes and identifies every bellflower available for garden use in the United States. The descriptions are detailed and complete. There are fifty black-and-white drawings.

The late Dr. Bailey was dean of American horticulturists. On March 15 (1954) he celebrated his ninety-sixth birthday. He was a professor, Director and Dean of Agriculture at Cornell University for many years. He is the author of more than 65 books, many of them world famous such as his *Hortus: A Concise Dictionary of Gardening* (1930), *Plant Breeding* (1895), *Principles of Fruit Growing* (1897), *Gardener's Handbook* and the more recent *The Garden of Gourds, The Garden of Pinks,* and *The Garden of Larkspurs.* Recipient of many honors, awards, and medals, Dr. Bailey traveled extensively over the world, studying and gathering plants—interior of South America (9 times), China, Japan, Korea, West Indies, and so on. As recently as his ninetieth birthday he spent in the West Indies and South America in search of tropical palm specimens.

SHEPHERD, ROY E. *History of the Rose.* New York (60 Fifth Avenue): The Macmillan Company, 1954. 264 P. $4.75.

History of the Rose is a factual work recording what is known about the rose and about the

growing of it from the earliest periods. It is claimed that this is the most complete history of the rose ever to appear in a book.

After an introductory chapter on the general history, the author discusses in turn each of the eleven groups into which he classifies roses. These are: A Group of Climbing Roses; Chinese Roses and Some Historic Hybrids; Four Asiatics and a New World Trio; The French Rose and Its Relatives; Two Old World Roses; North American Roses; Rugosa Roses and Their Allies; Yellows—Austrian, Persian and Scotch; The Hybrid Perpetuals; The Hybrid Teas; and The Polyanthas.

Roses are listed by scientific and common names, descriptions are given and the history and interesting facts are included. Thus the total numbers mentioned runs into the thousands as the author has tried to make this book a complete compendium. Some black and white plates are scattered here and there. There is a chart pointing out rose dominance during the last 350 years. The index of rose names totals 17 pages. There is a rather comprehensive bibliography on significant books and articles on roses.

Altogether this is a book that will interest many people, dealing as it does with probably the most beloved of all flowers—the rose.

SYMPOSIUM. *Insect Facts.* Washington, D. C.: Agricultural Research Service, U. S. Department of Agriculture, 1954.

Entomology celebrates its one-hundredth birthday this year. Many activities are planned by the 4,500 scientists, teachers and commercially-employed men and women. A special kit has been produced on *Insect Facts.* Its purpose is to aid public understanding of the importance of insects as destroyers and as man's helpers. Teachers will find the kit very valuable in studying insects, diseases, and conservation.

Section I gives the centennial plans, names and addresses of leading entomologists, radio and TV program outlines, and educational booklets. Section II gives information about important insect pests, diseases carried by insects, insecticides, biological and other controls, entomological odds and ends, specific insects harmful to certain plants and animals. Section III has many picture stories and significant charts.

JONES, ROY W. AND WALLEN, J. E. *Biological Science Notebook.* Minneapolis, Minnesota: Burgess Publishing Company, 1954. 90 P.

This is a combined notebook—laboratory manual designed for use in a two semester general biological science course. The notebook outlines the lecture part of the course with integrating laboratory experiments.

THE AMERICAN HEART ASSOCIATION. *The Heart Story.* (44 East 23rd Street): American Heart Association, Inc. 1953. 44 P. Free.

This 1953 Annual Report of the American Heart Association summarizes the great progress made in the last thirty years in the treatment of heart disease. There are five facts every one should know about heart disease: 1. Some forms of heart disease can be prevented—a few can be cured; 2. All heart cases can be cared for best if diagnosed early; 3. Almost all heart conditions can be helped by proper treatment; 4. Most heart patients can keep on working—often at the same job; and 5. Your "symptoms" may or may not mean heart disease. Don't guess or worry. See your doctor and be sure.

MORWOOD, JOHN. *Sailing Aerodynamics.* New York: Philosophical Library, 1955. 124 P. $7.50.

Sailing Aerodynamics presents for the amateur the theory of sailing. Eighty-two illustrations supplement the textual material.

KRAITCHIK, MAURICE. *Mathematical Recreations.* New York (1780 Broadway): Dover Publications, Inc. 1953. 330 P. $1.60.

This is one of the most complete and interesting books on mathematical recreations one is likely to find. Teachers of mathematics, and students of mathematics as well as any laymen interested in the field of mathematics—especially those interested in puzzles, recreation, hard to solve and unusual problems will find this book a real treat. Numerous illustrations accompany the textual material. A teacher of mathematics will find here sufficient problems to whet the interest and ability of all mathematical students.

There are chapters on: Mathematics Without Numbers, Ancient and Curious Problems, Numerical Pastimes, Arithmetic—Geometrical Questions, The Calendar, Probabilities, Magic Squares, Geometric Recreations, Permutation Problems, The Problems of the Queen, The Problem of the Knight, and Gomer.

This is surely a book that every mathematics classroom teacher should have. He will find it a means of adding spice and variety to his course and might make an otherwise uninterested and day-dreaming student take an interest in what has been called the queen of the sciences. The book is highly recommended to all mathematics teachers and for the mathematics book shelf.

STRUIK, DARK J. *A Concise History of Mathematics.* New York (1780 Broadway) Dover Publications, Inc. 1953, 299 P. $1.60.

Originally appearing in two volumes this concise history of mathematics covers the subject from its earliest beginnings until 1900. Oriental, Greek Egyptian, Chinese, Babylonian, Indian, Arabian, and western mathematics are covered. All of the significant aspects have been covered in a most scholarly way in a literary style advanced high school students of mathematics can readily read. Such students along with teachers of mathematics should thoroughly appreciate this book. For them it is recommended as a fine book as well as a most desirable addition to the high school mathematics book shelf.

D'Albro, A. *The Rise of the New Physics. Volumes I and II.* New York (1780 Broadway): Dover Publications, 982 pages (both volumes). $1.95 each.

The volumes were formerly entitled "Decline of Mechanism." Volume I presents a discussion of such matters as the historical background of the scientific method, theoretical physics, causality, conservation, and the physical theories of the classical period. Volume II deals somewhat completely with the quantum theory. Much of this discussion is on theories of the structure of matter such as the Bohr atom, DeBrogli's wave mechanics, Schrodinger's theory of radiation and Dirac's transformation theory. College students with some mathematical background can readily read this rather thorough discussion of modern physical theories.

Bent, Arthur Cleveland. *Life Histories of North American Fowl: Ducks, Geese, and Swans. Volumes I and II.* New York (1780 Broadway); Dover Publications, 312 P. and 392 P. $8.00 for both volumes.

These two volumes make available in print again the well-known Bent series on Ducks, Geese, and Swans. It is said that unbound, worn copies of these books have sold at $20 to $25 in the out-of-print markets. Evidently the volumes have been a sort of reference bible for all students of North American wild fowl. They have been widely praised by such nature lovers as the well-known writer E. W. Teale and Dr. John T. Zimmer of the American Museum of Natural History. The latter describes the books as unequalled for completeness and an outstanding contribution to the study of birds.

The volumes include the quoted comments and observations of such well-known ormithologists as Audubon, Chapman, Wetmore, Eaton, Forbush, Bailey, Grinnel, Nuttall, Saunders, Witherby, and others.

Volume I has 48 pages of pictures and Volume II has 64 pages of pictures. The volumes are not dry as dust references but are most readable. Undoubtedly they constitute a reference bible upon the life of wild fowl. Many other volumes are being published making a complete set of volumes of *Life Histories of North American Wild Fowl.*

Cheskin, Louis. *How To Color-Tune Your Home.* New York: The Macmillan Company, 1954. 150 P. $5.00.

Man lives in a colorful world and reacts subconsciously and psychologically to this environment. It is only in comparatively recent times that man has had an opportunity to react to important additions to his color world through his clothing, reading, home, and business environment. This book primarily discusses color in the home. To a large degree the home has become the most important color phase of his environment. Man can do much in determining the nature of his home color environment.

In this book the author discusses many aspects of color in the home more from the scientific and psychological aspects than the merely decorative phases. The author gives fundamental rules for color-tuning the home. There are 12 color charts that show 300 colors systematized in harmonious combinations and 12 examples of color-tuned interiors based on the color charts. With these charts the best color combinations for the home can readily be determined.

Among topics discussed are: Color is not a frill, we eat with our eyes, emotional problems and color, a color plan for each room, what colors should you have if you are a brunette? psychological and social factors in color preference, and how to use color charts.

This is a highly recommended book for all persons interested in color. Science teachers in high school and general physical science courses will find examples of many practical applications of the use of the color and the fundamental science principles involved.

Einstein, Albert. *Essays in Science.* New York (15 East 40th Street): Philosophical Library, 1954. 114 P. $2.75.

Essays in Science is the authorized English translation of the author's *Mein Weltbild.* This abridged edition omits the essays on Judaism, Germany, Politics, and Pacifism found in the original. Included are essays on Principles of Research, Inaugural Address to the Prussian Academy of Science, On Scientific Truth, On the Theory of Relativity, What Is the Theory of Relativity, Notes on the Origin of the General Theory of Relativity, Relativity and the Ether, and Address at Columbia University. These essays are most readable and are non-technical in treatment. Much of Einstein's philosophy of life and science is revealed in these essays.

Barrell, Joseph. *A Philosophical Study of the Human Mind.* New York: (15 East 40th Street): Philosophical Library, 1954. 575 P. $6.00.

Professor Barrell of Beloit College in this book proposes a new system of psychology employing the synoptic method proposed and used by Plato. In this method, the philosopher steps apart from the specialists and tries to embrace their work in one comprehensive vision. He avoids the specialization even of his own profession and puts his survey, not in technical language, but in the language of the common, well-educated individual of his time.

Dr. Barrell does this remarkably well in this most interesting, well-written treatise. It is nontechnical, utilizing many illustrative case-histories from the authors' own experience. Different types of personalities are described. No one person completely fits a given type, for example, such as extrovert or introvert, subjective or objective, thinking or feeling. We may be more one or the other, but never completely one type. Altogether this is a most interesting book to read whether or not you agree wholly, partly, or not at all, with Dr. Barrell's major theses.

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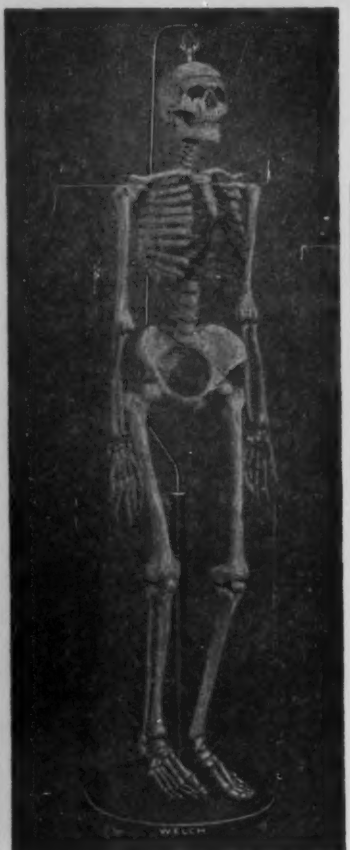

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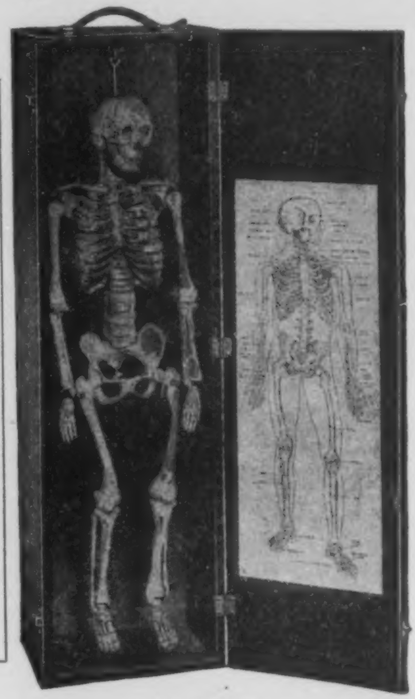

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